United States
Department of
Agriculture

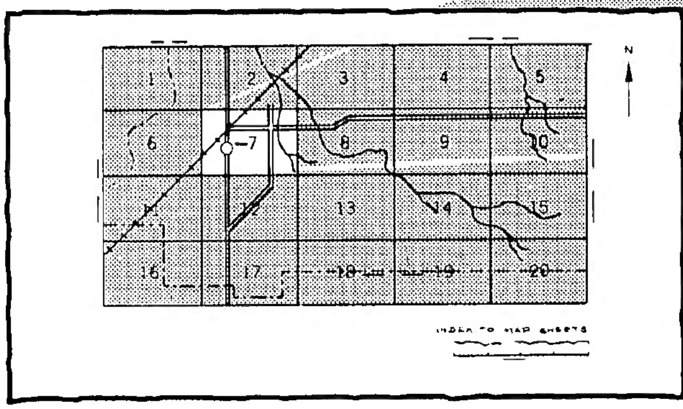
Soil
Conservation
Service

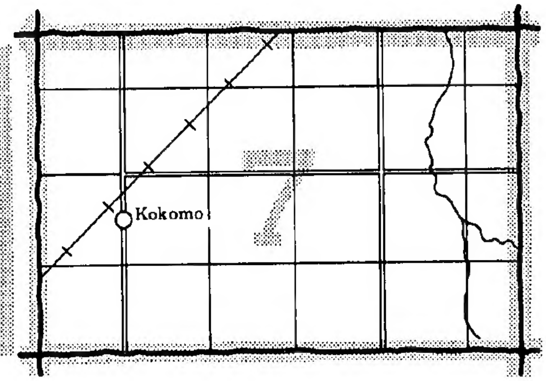
In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Graham County, Kansas

HOW TO USE

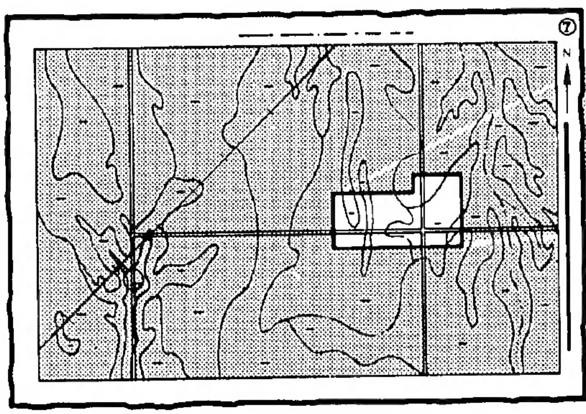
1. Locate your area of interest on the "Index to Map Sheets"

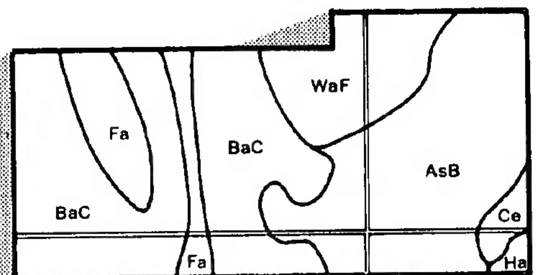




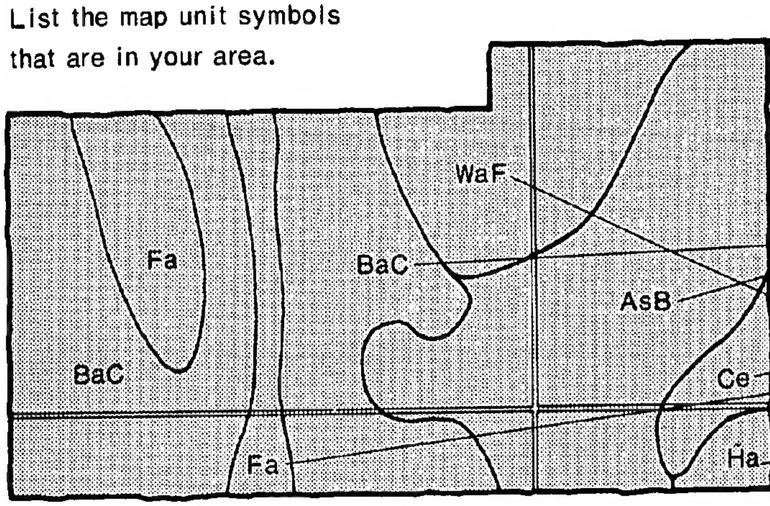
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.





4. List the map unit symbols that are in your area.



Symbols

AsB
BaC
Ce
Fa
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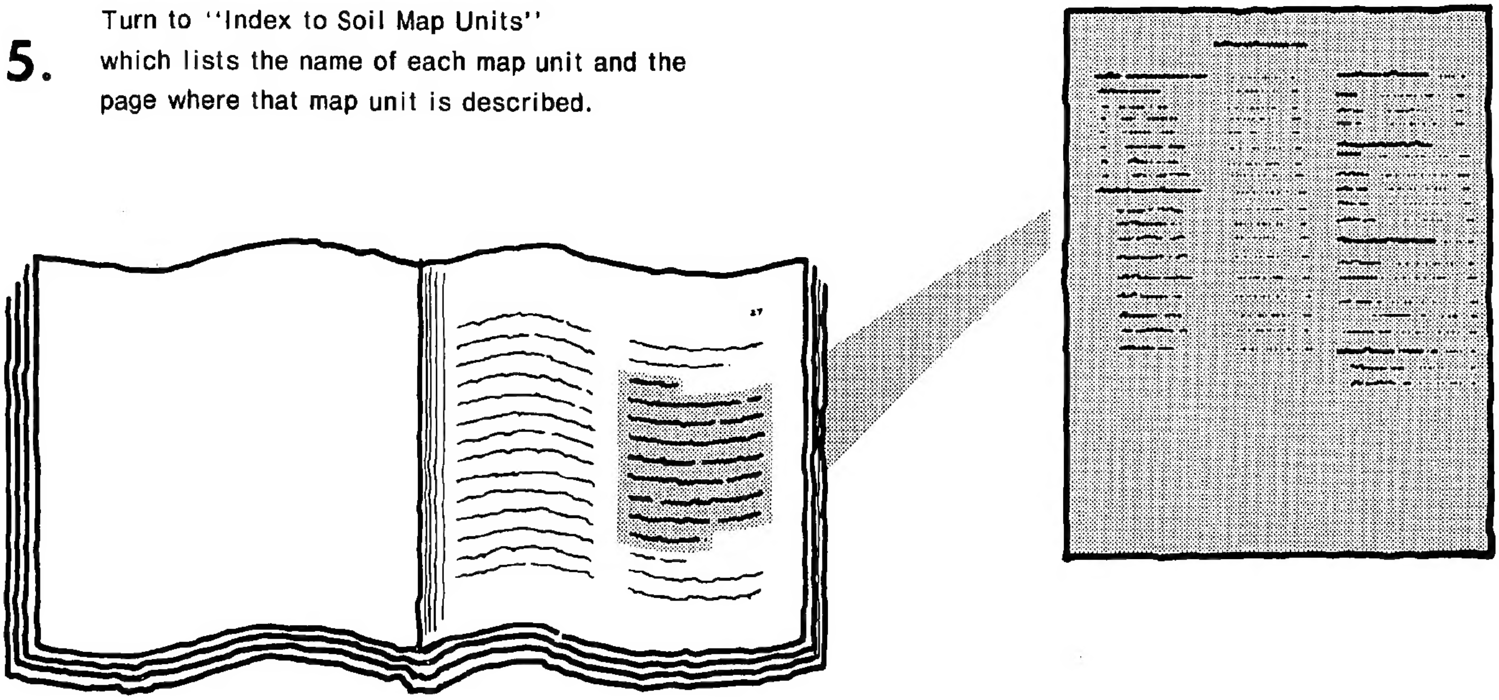
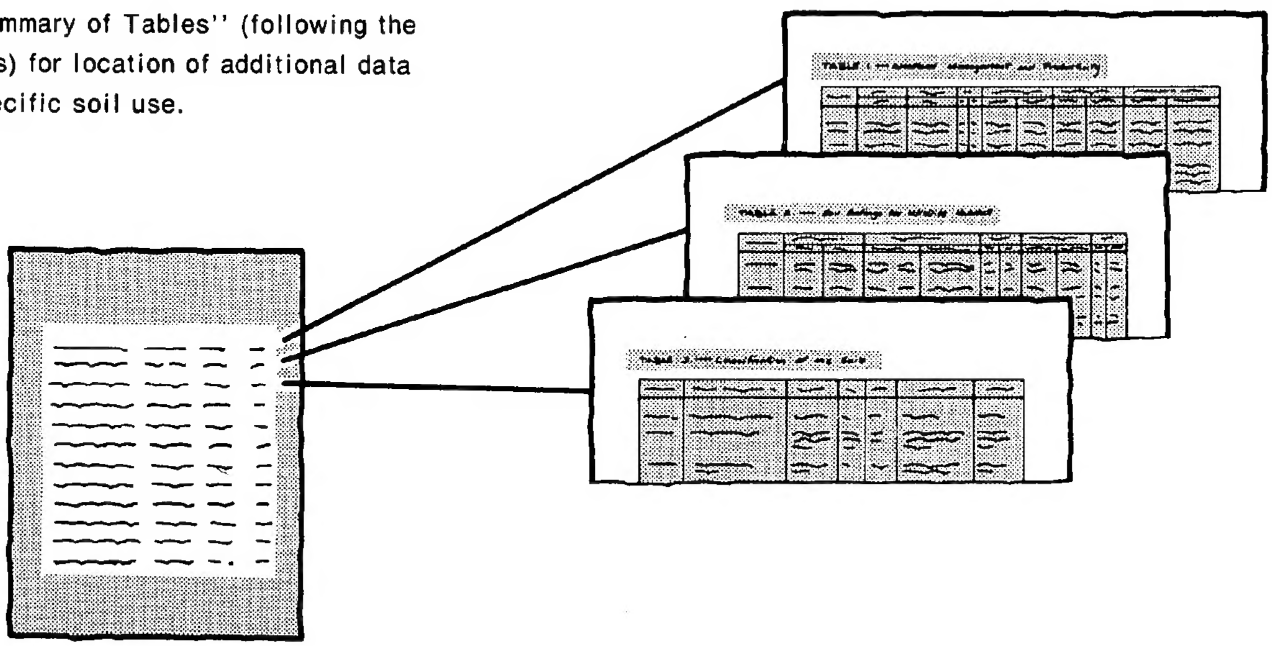
WaF

THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1984. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1984. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Graham County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Typical area of Campus-Canlon loams, 6 to 30 percent slopes. An area of the Penden-Uly complex, 7 to 20 percent slopes, is in the background. These map units are suited to range.

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Soil Series

Issued October 1986

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Graham County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

John W. Tippie

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State Conservationist
Soil Conservation Service

Soil Survey of Graham County, Kansas

By Cleveland E. Watts, Donald R. Jantz, and Stanley A. Glaum,
Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Kansas Agricultural Experiment Station

GRAHAM COUNTY is in the northwestern part of Kansas (fig. 1). It has a total area of 575,079 acres, or about 899 square miles. In 1982, the population was 4,114. About half of the population lives in Hill City, the county seat. The remaining population generally lives in the smaller outlying towns of Bogue, Morland, Nicodemus, Penokee, and St. Peter.

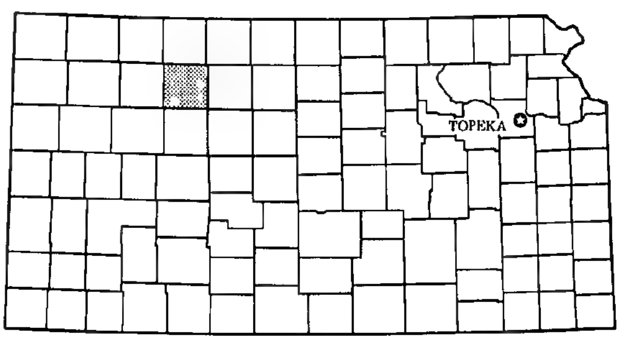

Figure 1.—Location of Graham County in Kansas.

Graham County is in the Rolling Plains and Breaks major land resource area. Elevation ranges from about 1,900 feet above sea level where the South Fork of the Solomon River leaves the county to about 2,600 feet near the northwest corner. The county is drained by the South Fork of the Solomon River, the Saline River, Bow Creek, and their tributaries.

The economy of the county is based primarily on farming, ranching, oil production, and related enterprises.

General Nature of the County

This section gives general information concerning the county. It describes climate and natural resources.

Climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Graham County is typical continental, as can be expected of a location in the interior of a large landmass in the middle latitudes. The climate is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of polar air. The cold temperatures prevail only from December to February. Warm summer temperatures prevail for about 6 months every year. They provide a long growing season for the crops grown in the county. Spring and fall are relatively short.

Graham County is generally to the west of the flow of moisture-laden air from the Gulf of Mexico and is to the east of the strong rain-shadow effects of the Rocky Mountains. As a result, the annual amount of precipitation is marginal for cropping year after year. The precipitation generally falls during showers and thunderstorms that can be extremely heavy at times. Winds are relatively high and can cause significant soil loss and crop damage in the drier years.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Hill City in the period 1951 to 1976. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 30.3 degrees F, and the average daily minimum temperature is 17.3 degrees. The lowest temperature on record, which occurred at Hill City on January 12, 1912, is -24 degrees. In summer the average temperature is 76.2 degrees, and the average daily maximum temperature is 89.5 degrees. The highest recorded temperature, which occurred on July 24, 1936, is 117 degrees.

The total annual precipitation is 22.66 inches. Of this, 17.53 inches, or 77 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 11.54 inches. The heaviest 1-day rainfall on record was 7.43 inches at Hill City on September 17, 1917.

Severe windstorms and occasional tornadoes accompany well developed thunderstorms, but they are infrequent and of local extent. Losses from hail are more severe, but they are not so great as the losses in counties to the west of this county.

The average seasonal snowfall is 27.5 inches. The highest recorded seasonal snowfall, which occurred during the winter of 1957-58, was 57 inches. On the average, 35 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The sun shines 77 percent of the time possible in summer and 67 percent in winter. The prevailing wind is from the north. Average windspeed is highest, 13 miles per hour, in March.

Natural Resources

Jon D. Deege, district conservationist, Soil Conservation Service, helped prepare this section.

Soil is the most important natural resource in the county. It provides a growing medium for cash crops and for the grasses grazed by livestock. More than half of the soils in the county are well suited to cultivated crops. The steeper, shallow and moderately deep soils produce good-quality native grasses.

Generally, adequate quantities of underground water are available for domestic and livestock use. A relatively small amount of ground water is available for irrigation. Water in sufficient quantity for irrigation is available from the Ogallala Formation in the northwestern part of the county. It also is available in the valley of the South Fork of the Solomon River.

The county has an adequate supply of sand and gravel for local use. The supply is fairly well distributed throughout the county.

Oil was first discovered in the southeastern part of the county in 1938. Currently, producing wells are in almost all areas of the county.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists

classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Soil Descriptions

1. Holdrege-Uly-Coly Association

Deep, nearly level to moderately steep, well drained soils that have a silty subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by many intermittent drainageways and small streams. Slopes range from 0 to 20 percent.

This association makes up about 19 percent of the county. It is about 60 percent Holdrege soils, 15 percent Uly soils, 15 percent Coly soils, and 10 percent minor soils (fig. 2).

The nearly level and gently sloping Holdrege soils formed in loess on ridgetops and side slopes. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 14 inches thick. The upper part is pale brown, firm silty clay loam, and the lower part is very pale brown, calcareous, friable silt loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The moderately sloping to moderately steep Uly soils formed in loess on side slopes. Typically, the surface layer is grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The moderately sloping and strongly sloping Coly soils formed in loess on side slopes. Typically, the surface layer is pale brown, calcareous silt loam about 6 inches thick. The next layer is very pale brown, friable, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The minor soils in this association are the Hord, Humbarger, and Penden soils. Hord soils are subject to rare flooding and are on stream terraces. The loamy Humbarger soils are on flood plains. The loamy Penden soils are on the lower side slopes.

This association is used mostly for cultivated crops; however, the strongly sloping and moderately steep Uly soils are used as range. Wheat, grain sorghum, and forage sorghum are the main crops. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are main concerns in managing the cultivated areas. Maintaining the growth and vigor of desirable grasses and forbs is the main concern in managing range.

2. Holdrege-Uly-Penden Association

Deep, nearly level to moderately steep, well drained soils that have a silty or loamy subsoil; on uplands

This association is on ridgetops and side slopes that are dissected by many intermittent drainageways and small streams. Slopes range from 0 to 20 percent.

This association makes up about 53 percent of the county. It is about 60 percent Holdrege soils, 20 percent Uly soils, 15 percent Penden soils, and 5 percent minor soils (fig. 3).

The nearly level and gently sloping Holdrege soils formed in loess on ridgetops and side slopes. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about

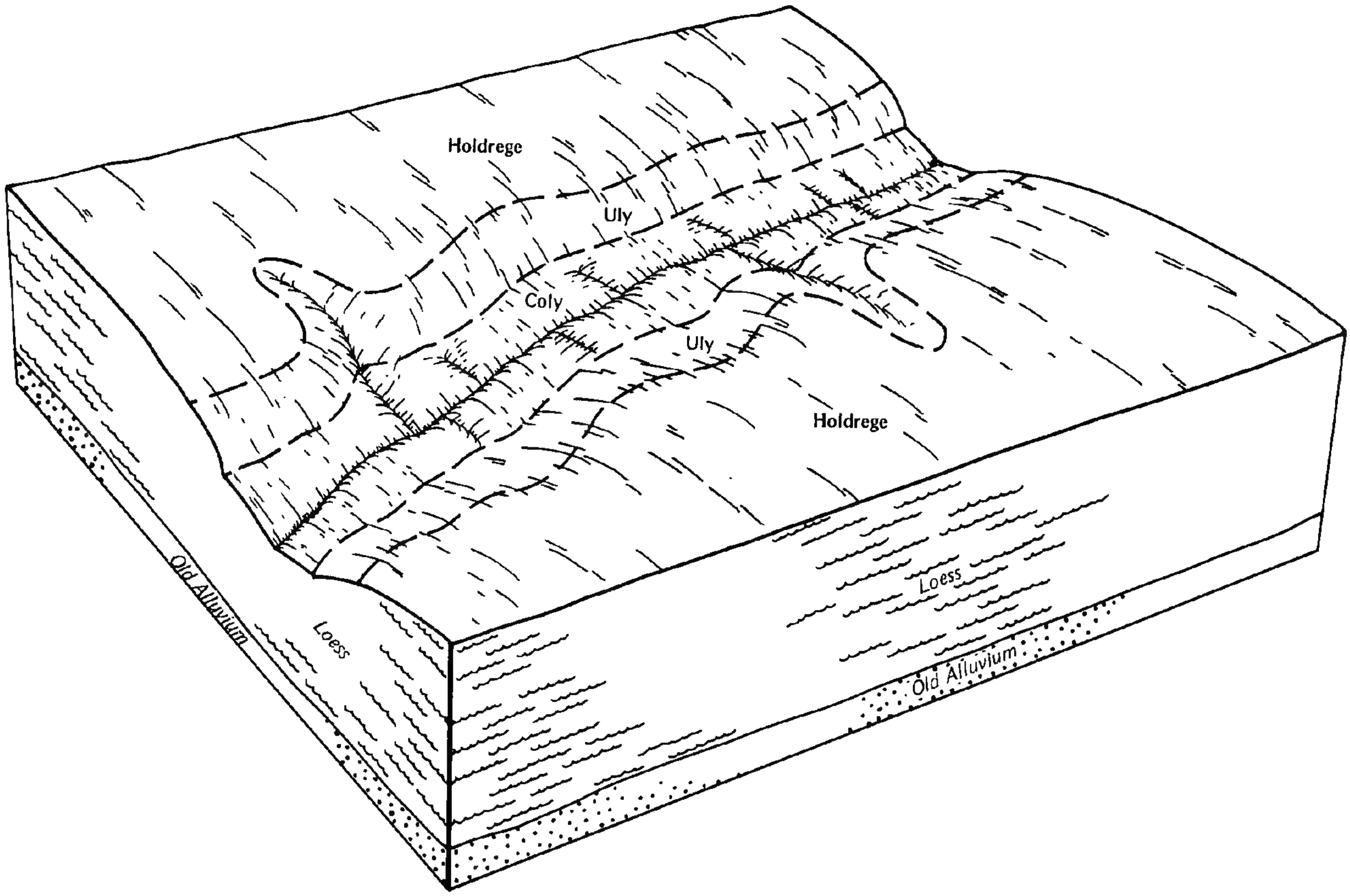

Figure 2.—Typical pattern of soils and parent material in the Holdrege-Uly-Coly association.

14 inches thick. It is friable. The upper part is pale brown silty clay loam, and the lower part is very pale brown, calcareous silt loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The moderately sloping to moderately steep Uly soils formed in loess on side slopes. Typically, the surface layer is grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The moderately sloping to moderately steep Penden soils formed in calcareous, loamy sediments on side slopes. Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 10 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 10 inches thick. The upper part of the substratum is brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam.

The minor soils in this association are the Canlon, Humbarger, and Wakeen soils. The shallow, somewhat excessively drained, moderately sloping and strongly sloping Canlon soils are on side slopes. The deep Humbarger soils are on flood plains. The moderately deep, moderately steep Wakeen soils are on side slopes and breaks.

About two-thirds of this association is used for cultivated crops. The rest is used mainly as range. Wheat, grain sorghum, and forage sorghum are the main crops. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Maintaining the growth and vigor of desirable grasses and forbs is the main concern in managing range.

3. Hord-Bridgeport-Munjor Association

Deep, nearly level, well drained soils that have a silty or loamy and sandy subsoil; on stream terraces and flood plains

This association is on terraces and flood plains along the major streams in the county. The Munjor soils are occasionally flooded. The Bridgeport and Hord soils are subject to rare flooding. Slopes range from 0 to 2 percent.

This association makes up about 7 percent of the county. It is about 43 percent Hord soils, 20 percent Bridgeport soils, 20 percent Munjor soils, and 17 percent minor soils.

The Hord soils formed in a mixture of loess and alluvium on stream terraces. Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark gray silt loam about 5 inches thick. The subsoil is friable silt loam about 28 inches thick. The upper part is grayish brown, and the lower part is light brownish gray and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam.

The Bridgeport soils formed in calcareous alluvium on flood plains. Typically, the surface layer is dark grayish brown, calcareous silt loam about 6 inches thick. The subsurface layer is grayish brown, calcareous silt loam about 12 inches thick. The subsoil is grayish brown, friable, calcareous silt loam about 17 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam.

The Munjor soils formed in loamy and sandy sediments on flood plains. Typically, the surface layer is grayish brown, calcareous sandy loam about 6 inches thick. The substratum to a depth of about 60 inches is calcareous. The upper part is pale brown loamy sand; the next part is light brownish gray fine sandy loam; and the lower part is light gray sand.

The minor soils in this association are the Anselmo, Humbarger, and Inavale soils. Anselmo soils are on upland side slopes. They are not stratified. The loamy Humbarger soils are on flood plains along the smaller

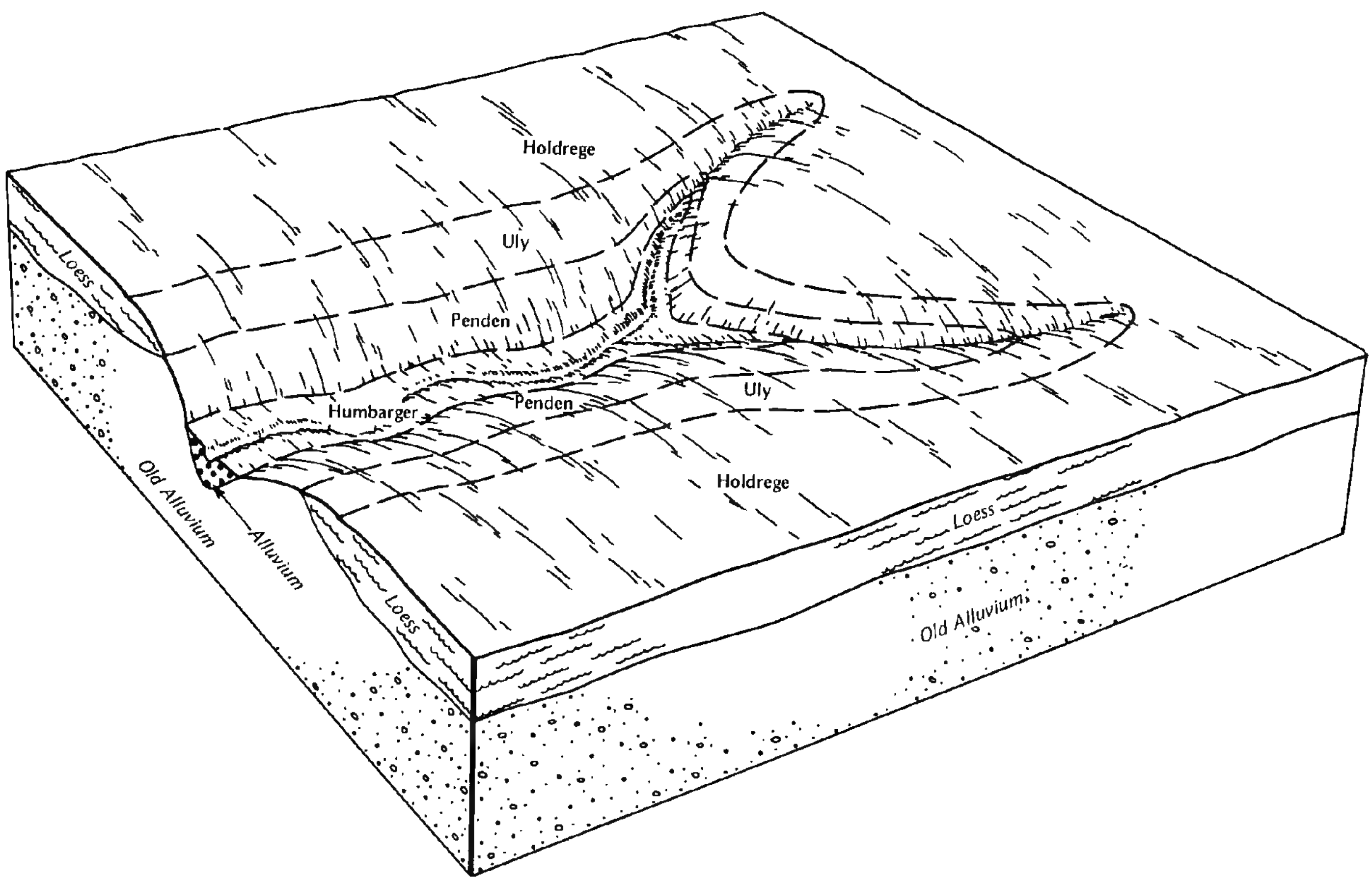

Figure 3.—Typical pattern of soils and parent material in the Holdrege-Uly-Penden association.

streams. The sandy Inavale soils are in the slightly lower areas on flood plains along the South Fork of the Solomon River.

This association is used mostly for cultivated crops. Wheat, grain sorghum, forage sorghum, and alfalfa are the main crops. Controlling flooding and maintaining tilth and fertility are main concerns in managing the cultivated areas.

4. Uly-Penden-Wakeen Association

Deep and moderately deep, moderately sloping to moderately steep, well drained soils that have a silty or loamy subsoil; on uplands

This association is on side slopes that are dissected by many short drainageways. Some areas have deeply entrenched valleys. Outcrops of shaly bedrock are common on the steeper slopes. Slopes range from 2 to 20 percent.

This association makes up about 21 percent of the county. It is about 45 percent Uly soils, 20 percent Penden soils, 15 percent Wakeen soils, and 20 percent minor soils (fig. 4).

The moderately sloping to moderately steep Uly soils formed in loess on side slopes. Typically, the surface layer is grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The moderately sloping to moderately steep Penden soils formed in calcareous, loamy sediments on side slopes. Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 10 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 10 inches thick. The upper part of the substratum is pale brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam.

The moderately sloping to moderately steep Wakeen soils formed in material weathered from chalky limestone and shale on side slopes. Typically, the surface layer is dark grayish brown, calcareous silt loam about 12 inches thick. The subsoil is friable, calcareous silty clay loam

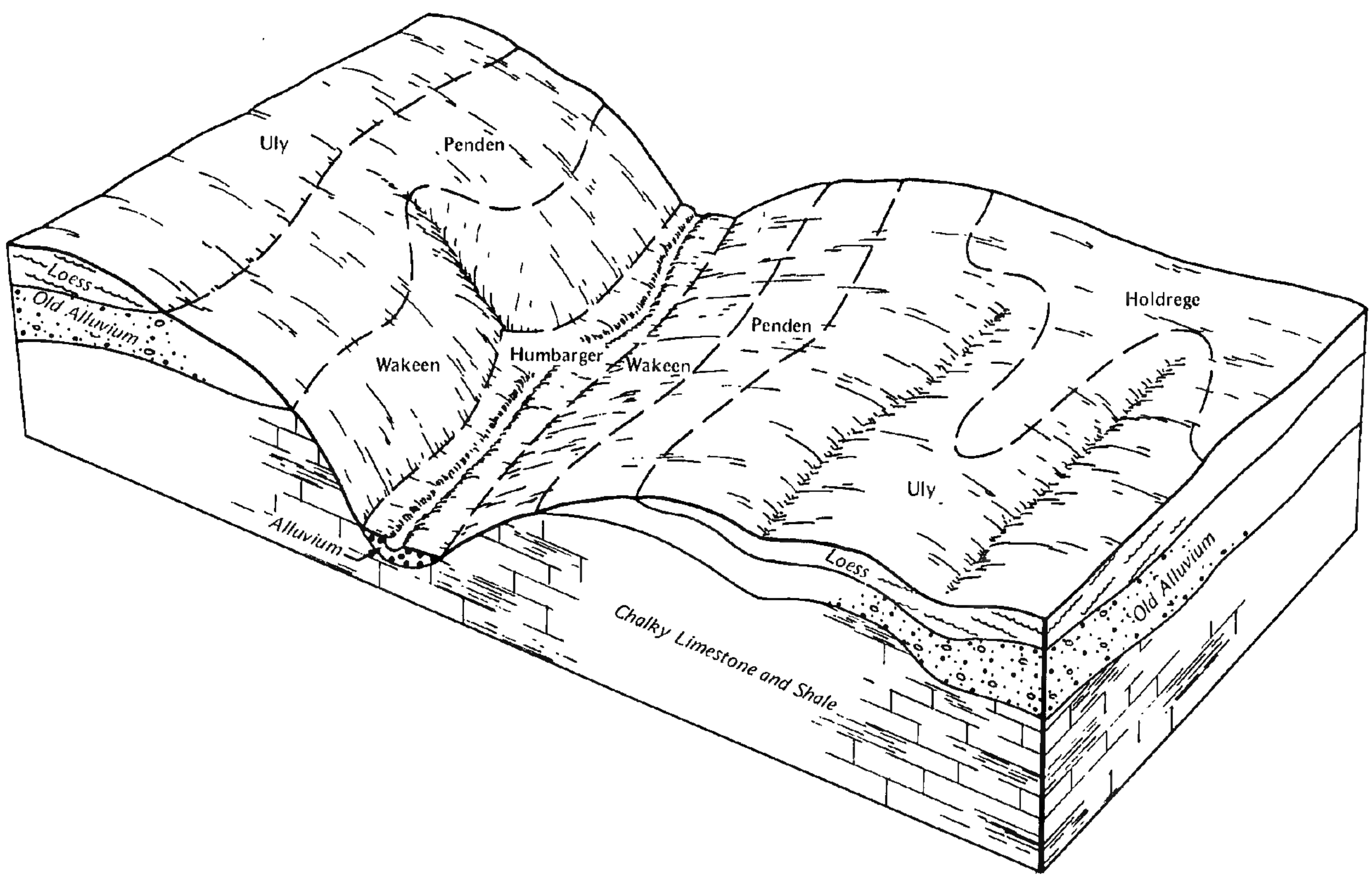

Figure 4.—Typical pattern of soils and parent material in the Uly-Penden-Wakeen association.

about 21 inches thick. The upper part is pale brown, and the lower part is very pale brown. Chalky limestone and shale are at a depth of about 33 inches.

The minor soils in this association are the Armo, Canlon, Eltree, Holdrege, Humbarger, and Nibson soils. Armo and Eltree soils are on foot slopes. The shallow, moderately steep Canlon soils are on sharp breaks. The nearly level and gently sloping Holdrege soils are on ridgetops and side slopes. Humbarger soils are on flood plains. The shallow, somewhat excessively drained, moderately steep Nibson soils are on side slopes.

About half of this association is used for cultivated crops. The rest is used as range. Wheat, grain sorghum, and forage sorghum are the main crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are main concerns in managing the cultivated areas. Maintaining the growth and vigor of desirable grasses and forbs is the main concern in managing range.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Holdrege silt loam, 0 to 1 percent slopes, is a phase in the Holdrege series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Penden-Uly complex, 7 to 20 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil Descriptions

An—Anselmo sandy loam, 2 to 6 percent slopes. This deep, moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 70 acres in size.

Typically, the surface layer is grayish brown sandy loam about 10 inches thick. The subsoil is brown, friable fine sandy loam about 16 inches thick. The substratum to a depth of about 60 inches is light yellowish brown loamy fine sand. In places the surface layer is calcareous.

Included with this soil in mapping are small areas of Penden soils. These soils are higher on the landscape than the Anselmo soil. Also, they have more clay in the subsoil. They make up about 5 percent of the map unit.

Permeability is moderately rapid in the Anselmo soil. Available water capacity and organic matter content are moderate. Surface runoff and natural fertility are medium. The surface layer is neutral. It is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Some small areas are used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and forage sorghum. Water erosion and soil blowing are hazards if cultivated crops are grown. Terraces, grassed waterways, contour farming, wind stripcropping, cropping systems that include grasses or legumes, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other

organic material improve tilth and fertility and increase the infiltration rate.

Most areas are used as range. The native vegetation is dominantly sand bluestem, little bluestem, and prairie sandreed. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as western wheatgrass and blue grama. Water erosion and soil blowing are hazards if the range is overgrazed. They can be controlled by maintaining an adequate plant cover. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil is well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IIIe, and the range site is Sandy.

As—Armo loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on foot slopes and side slopes. Individual areas are irregular in shape and range from 30 to 80 acres in size.

Typically, the surface layer is grayish brown, calcareous loam about 6 inches thick. The subsurface layer is about 12 inches thick. The upper part is dark grayish brown, calcareous loam. The lower part is grayish brown, calcareous clay loam. The subsoil is friable, calcareous clay loam about 28 inches thick. The upper part is light brownish gray, and the lower part is very pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of Eltree and Wakeen soils. The silty Eltree soils are on the lower foot slopes. The moderately deep Wakeen soils are on the higher side slopes. Included soils make up about 10 percent of the map unit.

Permeability and organic matter content are moderate in the Armo soil. Available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is mildly alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content.

About half of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

About half of the acreage is range. The native vegetation is dominantly big bluestem, little bluestem, and indiangrass. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss and blue grama. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as pheasants. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is well suited to dwellings and septic tank absorption fields. It is only moderately well suited to sewage lagoons because of seepage and slope. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Limy Upland.

Br—Bridgeport silt loam. This deep, nearly level, well drained soil is on flood plains. It is subject to rare flooding. Individual areas are irregular in shape and range from 80 to 320 acres in size.

Typically, the surface layer is dark grayish brown, calcareous silt loam about 6 inches thick. The subsurface layer is grayish brown, calcareous silt loam about 12 inches thick. The subsoil is grayish brown, friable, calcareous silt loam about 17 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In places the dark surface soil is more than 20 inches thick.

Included with this soil in mapping are small areas of the loamy Munjor soils on flood plains along stream channels. Also included are small areas of loamy soils on terrace escarpments or on short, steep slopes between stream terraces and the flood plains. Included soils make up about 10 percent of the map unit.

Permeability is moderate in the Bridgeport soil, and surface runoff is slow. Available water capacity, organic matter content, and natural fertility are high. The surface layer is moderately alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Inadequate rainfall is a problem if cultivated crops are grown. Summer fallowing helps to conserve moisture. It is most effective when the crop residue is managed by stubble mulching or by chemical fallow. Stubble mulching also is effective in trapping snow. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the infiltration rate.

This soil is poorly suited to dwellings and moderately well suited to septic tank absorption fields. The flooding is a hazard affecting both uses. Flood-control structures, such as dikes and levees, are needed. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected. The soil is only moderately well suited to sewage lagoons because of seepage. Sealing the floor and walls of the lagoon helps to overcome this limitation.

The land capability classification is IIc, and the range site is Loamy Terrace.

Cc—Campus-Canlon loams, 6 to 30 percent slopes. These strongly sloping to steep soils are on side slopes above caliche rock outcrops. The landscape is dissected by deeply entrenched drainageways. The moderately deep, well drained Campus soil is on the less sloping, upper side slopes. The shallow, somewhat excessively drained Canlon soil is on the steeper mid slopes directly above the areas where caliche crops out. Individual areas are long and narrow and range from 10 to several hundred acres in size. They are about 55 percent Campus soil and 30 percent Canlon soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Campus soil has a surface layer of dark grayish brown, calcareous loam about 8 inches thick. The subsurface layer is gray, calcareous loam about 7 inches thick. The subsoil is about 15 inches thick. The upper part is light gray, firm, calcareous clay loam, and the lower part is white, firm, calcareous loam. White, hard caliche is at a depth of about 30 inches.

Typically, the Canlon soil has a surface layer of grayish brown, calcareous loam about 3 inches thick. The next layer is light brownish gray, calcareous loam about 3 inches thick. The substratum is light brownish gray, calcareous very gravelly loam about 6 inches thick. White, hard caliche is at a depth of about 12 inches.

Included with these soils in mapping are small areas of Humbarger and Penden soils and caliche outcrops. The deep Humbarger soils are on flood plains. The deep Penden soils are on side slopes above the Campus and Canlon soils. The caliche outcrops are on steep bluffs below the Campus and Canlon soils. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Campus and Canlon soils. Available water capacity and natural fertility are low. Organic matter content is moderate in the Campus soil and low in the Canlon soil. Surface runoff is rapid on both soils. Root penetration is restricted by the caliche at a depth of about 30 inches in the Campus soil and about 12 inches in the Canlon soil. Both soils are moderately alkaline throughout.

Most areas are used as range. Because of the water erosion hazard on both soils and the shallowness to hard caliche in the Canlon soil, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and switchgrass. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as blue grama and hairy grama. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

The Campus soil is poorly suited to dwellings, septic tank absorption fields, and sewage lagoons because of the depth to bedrock. The slope also is a limitation on sites for sewage lagoons. The deeper included soils are better suited to building site development.

The Canlon soil is generally unsuited to building site development because of the depth to bedrock and the slope.

The land capability classification is VIe. The Campus soil is in the Limy Upland range site, and the Canlon soil is in the Shallow Limy range site.

Cn—Coly silt loam, 2 to 6 percent slopes. This deep, moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is pale brown, calcareous silt loam about 6 inches thick. The next layer is very pale brown, friable, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In places the surface layer is silty clay loam or is noncalcareous.

Included with this soil in mapping are small areas of Holdrege, Humbarger, and Penden soils. These soils make up about 10 percent of the map unit. They have a dark surface layer. Holdrege and Penden soils have more clay in the subsoil than the Coly soil. Holdrege soils are on ridgetops and the upper side slopes. The loamy Penden soils are on side slopes below the Coly soil. The loamy Humbarger soils are on flood plains.

Permeability and organic matter content are moderate in the Coly soil. Available water capacity is high. Surface runoff is medium. Natural fertility is low. This soil is moderately alkaline throughout. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

This soil is well suited to dwellings and septic tank absorption fields. It is only moderately well suited to

sewage lagoons because of seepage and slope. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Limy Upland.

Co—Coly silt loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 30 acres in size.

Typically, the surface layer is pale brown, calcareous silt loam about 4 inches thick. The next layer is very pale brown, friable, calcareous silt loam about 7 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of Holdrege, Humbarger, and Penden soils. These soils make up about 10 percent of the map unit. They have a dark surface layer. Holdrege soils are on ridgetops and gently sloping side slopes above the Coly soil. The loamy Humbarger soils are on flood plains. The loamy Penden soils are on side slopes below the Coly soil.

Permeability and organic matter content are moderate in the Coly soil. Available water capacity is high. Surface runoff is rapid. Natural fertility is low. This soil is moderately alkaline throughout. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is poorly suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate. Reseeding abandoned cropland to grass helps to restore productivity and control erosion.

This soil is moderately well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons. The slope is a limitation affecting all of these uses. Dwellings should be designed so that they conform to the natural slope of the land. Installing the distribution lines across the slope helps to ensure that septic tank absorption fields function properly. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction. Land shaping is necessary in some areas.

The land capability classification is IVe, and the range site is Limy Upland.

Et—Eltree silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on foot slopes. Individual areas are irregular in shape and range from 30 to 320 acres in size.

Typically, the surface layer is grayish brown, calcareous silt loam about 9 inches thick. The subsurface layer is about 16 inches thick. It is dark grayish brown and calcareous. The upper part is silt loam, and the lower part is silty clay loam. The subsoil is friable, calcareous silt loam about 20 inches thick. The upper part is pale brown, and the lower part is very pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Permeability and organic matter content are moderate. Available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is mildly alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

This soil is well suited to dwellings and septic tank absorption fields. It is only moderately well suited to sewage lagoons because of seepage and slope. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, and the range site is Limy Upland.

Hf—Holdrege silt loam, 0 to 1 percent slopes. This deep, nearly level, well drained soil is on narrow upland ridgetops. Individual areas are irregular in shape and range from 10 to 320 acres in size.

Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 14 inches thick. It is friable. The upper part is pale brown silty clay loam, and the lower part is very pale brown, calcareous silt loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay loam. In places the soil has a more clayey subsoil or a buried surface layer.

Included with this soil in mapping are clayey soils in small depressions or swales. These soils make up about 2 percent of the map unit.

Permeability and organic matter content are moderate in the Holdrege soil. Surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is neutral. It is friable and can be easily tilled

throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Inadequate rainfall is a problem if cultivated crops are grown. Summer fallowing helps to conserve moisture. It is most effective when the crop residue is managed by stubble mulching or by chemical fallow. Stubble mulching also is effective in trapping snow. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the infiltration rate.

This soil is moderately well suited to dwellings and sewage lagoons. It is well suited to septic tank absorption fields. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IIc, and the range site is Loamy Upland.

Hg—Holdrege silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on broad ridgetops and side slopes (fig. 5). Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 14 inches thick. It is friable. The upper part is pale brown silty clay loam, and the lower part is very pale brown, calcareous silt loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In some areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay loam. In places the soil has a buried surface layer.

Included with this soil in mapping are small areas of Penden, Uly, and Wakeen soils. Also included are clayey soils in small depressions or swales. Penden and Uly soils are on side slopes below the Holdrege soil. Uly soils are less clayey than the Holdrege soil, and Penden soils are loamy. The moderately deep Wakeen soils are calcareous at or near the surface. They are on the lower side slopes. Included soils make up about 5 percent of the map unit.

Permeability and organic matter content are moderate in the Holdrege soil. Surface runoff is medium. Available water capacity and natural fertility are high. The surface layer is neutral. It is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

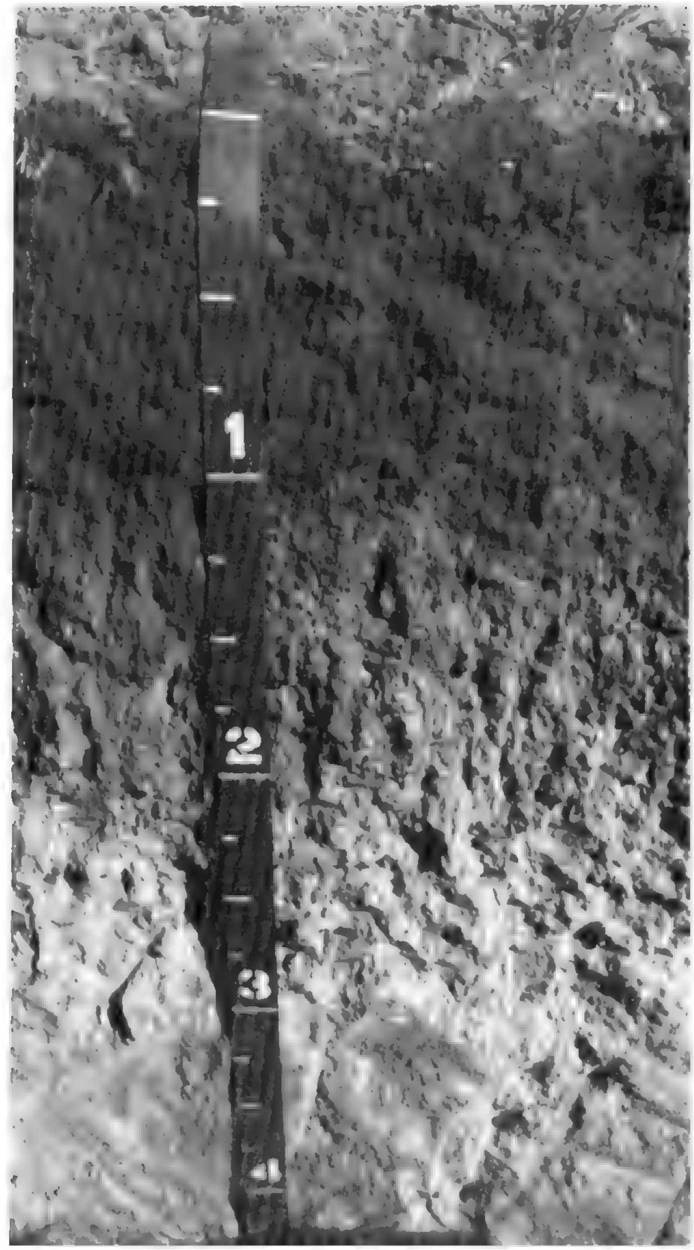

Figure 5.—Profile of Holdrege silt loam, 1 to 3 percent slopes. This soil formed in light colored loess. Depth is marked in feet.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to

the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as pheasants. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is moderately well suited to dwellings and sewage lagoons. It is well suited to septic tank absorption fields. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, and the range site is Loamy Upland.

Ho—Hord silt loam. This deep, nearly level, well drained soil is on terraces along intermittent drainageways and streams. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 8 inches thick. The subsurface layer is dark gray silt loam about 5 inches thick. The subsoil is friable silt loam about 28 inches thick. The upper part is grayish brown, and the lower part is light brownish gray and calcareous. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In places the depth to lime is less than 20 inches.

Included with this soil in mapping are small areas of the calcareous Armo and Eltree soils on foot slopes. These soils make up about 2 percent of the map unit.

Permeability and organic matter content are moderate in the Hord soil. Surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is neutral. It is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Inadequate rainfall is a problem if cultivated crops are grown. Summer fallowing helps to conserve moisture (fig. 6). It is most effective when the crop residue is managed by stubble mulching or by chemical fallow. Stubble mulching also is effective in trapping snow. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the infiltration rate.

This soil is poorly suited to dwellings and moderately well suited to septic tank absorption fields. The flooding is a hazard affecting both uses. Flood-control structures, such as dikes and levees, are needed. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected. The soil is only moderately well suited to sewage lagoons because of seepage. Sealing the lagoon helps to overcome this limitation.

The land capability classification is IIc, and the range site is Loamy Terrace.

Hu—Humbarger loam, channeled. This deep, nearly level, well drained soil is on flood plains along small creeks and intermittent drainageways. It is frequently flooded. Individual areas generally are narrow and elongated. They are 160 to 500 feet wide, 600 to several thousand feet long, and several hundred acres in size.

Typically, the surface layer is dark gray, calcareous loam about 21 inches thick. The next layer is grayish brown, friable, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous loam. In places the surface layer is more silty.

Permeability and organic matter content are moderate. Surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is moderately alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used as range. Because of the flooding and the difficulty in operating machinery along the meandering stream channels, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly big bluestem, western wheatgrass, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable plants, such as sedges and prairie cordgrass. Recurrent flooding, channeling, and deposition are hazards. Areas near watering facilities and shade trees where animals congregate are generally overused and in poor condition. Fencing and properly locating salt and watering facilities can help to distribute grazing evenly. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as quail, deer, rabbits, and numerous songbirds. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw, and the range site is Loamy Lowland.

Hw—Humbarger loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains.

Figure 6.—Summer fallowing in an area of Hord silt loam.

Individual areas are irregular in shape and range from 10 to 120 acres in size.

Typically, the surface layer is dark gray, calcareous loam about 21 inches thick. The next layer is grayish brown, friable, calcareous clay loam about 10 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous loam. In places the surface layer is more silty.

Permeability and organic matter content are moderate. Surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is moderately alkaline. It is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

About two-thirds of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and forage sorghum. If cultivated crops are grown, flooding is a hazard. It reduces crop yields in some years, but in other years the extra moisture can increase the yields. In years of above average rainfall, the flooding delays planting and harvesting and causes some crop damage. Overcoming the flooding hazard is difficult without major flood-control measures. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

About one-third of the acreage is range. The native vegetation is dominantly big bluestem, western wheatgrass, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less productive plants, such as sedges and prairie cordgrass. Areas near watering facilities and shade trees where animals congregate are generally overused and in poor condition. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range or woodland provides good habitat for many types of wildlife, including deer, quail, and numerous songbirds. Good woodland management can increase the wildlife population.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

If—Inavale sand, channeled. This deep, nearly level, excessively drained soil is on flood plains. It is frequently flooded. Individual areas are narrow and elongated. They range from 120 to 800 feet wide and are several miles long.

Typically, the surface layer is grayish brown sand about 6 inches thick. The substratum to a depth of about 60 inches is sand. The upper part is pale brown, and the lower part is very pale brown. In places the soil has finer textured strata.

Permeability is rapid, and surface runoff is slow. Available water capacity, organic matter content, and natural fertility are low. The surface layer is mildly alkaline. It is loose, and tillage is a problem when the soil is dry.

Most areas are used as range. Because of the flooding, the low available water capacity, the hazard of soil blowing, and the difficulty in operating machinery along the meandering stream channels, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly sand bluestem, little bluestem, and porcupinegrass. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, hairy grama, and blue grama. Soil blowing is a hazard if the range is overgrazed. Recurrent flooding, channeling, and deposition also are hazards. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is VIw, and the range site is Sands.

Ih—Inavale loamy sand, hummocky. This deep, excessively drained soil is along the major stream valleys. It is subject to rare flooding. Slope ranges from 0 to 9 percent. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is grayish brown loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is sand. The upper part is pale brown, and the lower part is very pale brown. In places the soil is calcareous throughout.

Permeability is rapid, and surface runoff is slow. Organic matter content, available water capacity, and natural fertility are low. The surface layer is mildly alkaline. It is loose, and tillage can be a problem under some moisture conditions.

Most areas are used as range. Because of the low available water capacity and the hazard of soil blowing, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly sand bluestem, little bluestem, and prairie sandreed. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, hairy grama, and blue grama. Soil blowing is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is VIe, and the range site is Sands.

Im—Inavale loamy sand, occasionally flooded. This deep, nearly level, excessively drained soil is on flood plains. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is grayish brown loamy sand about 6 inches thick. The substratum to a depth of about 60 inches is sand. The upper part is pale brown, and the lower part is very pale brown. In most areas the soil is calcareous throughout. In a few places the surface layer and substratum are sandy loam.

Permeability is rapid, and surface runoff is slow. Available water capacity, organic matter content, and natural fertility are low. The surface layer is mildly alkaline. It is loose, and tillage is a problem under some moisture conditions.

Most areas are used as range. Because of the low available water capacity and the hazard of soil blowing, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly sand bluestem, little bluestem, and prairie sandreed. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, hairy grama, and blue grama. Soil blowing is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IVe, and the range site is Sands.

Mu—Munjor sandy loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is grayish brown, calcareous sandy loam about 6 inches thick. The substratum is calcareous. The upper part is pale brown loamy sand. The next part is light brownish gray fine sandy loam. The lower part to a depth of about 60 inches is light gray sand.

Included with this soil in mapping are small areas of the silty Bridgeport soils on the higher parts of the flood plains. These soils make up about 5 percent of the map unit.

Permeability is moderately rapid in the Munjor soil, and surface runoff is slow. Available water capacity, organic matter content, and natural fertility are low. The surface layer is mildly alkaline. It is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Soil blowing is a hazard if cultivated crops are grown. Also, drought can significantly reduce yields. Terraces, grassed waterways, contour farming, wind stripcropping, cropping systems that include grasses or legumes, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range or woodland provides good habitat for many types of wildlife, such as deer, quail, and numerous songbirds. Good woodland management can increase the wildlife population.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIIw, and the range site is Sandy Lowland.

Ph—Penden loam, 3 to 8 percent slopes. This deep, moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 30 to 320 acres in size.

Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 10 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 10 inches thick. The upper part of the substratum is pale brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Campus, Humbarger, and Uly soils. The moderately deep Campus soils are on the lower side slopes. Humbarger soils are on flood plains. The silty Uly soils are on the upper side slopes. Included soils make up about 10 percent of the map unit.

Permeability and organic matter content are moderate in the Penden soil. Available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is mildly alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

About two-thirds of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

About one-third of the acreage is range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss and blue grama. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as pheasants. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed to overcome the slope. Seepage can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IIIe, and the range site is Limy Upland.

Pk—Penden clay loam, 3 to 8 percent slopes, eroded. This deep, moderately sloping, well drained soil

is on side slopes. Individual areas are irregular in shape and range from 10 to 50 acres in size.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 7 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 20 inches thick. The upper part of the substratum is pale brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam.

Included with this soil in mapping are small areas of Campus, Coly, Humbarger, and Uly soils. The moderately deep Campus soils are on side slopes below the Penden soil. The silty Coly and Uly soils are on side slopes above the Penden soil. Included soils make up about 10 percent of the map unit.

Permeability and organic matter content are moderate in the Penden soil. Available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is moderately alkaline. It is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is poorly suited to wheat, grain sorghum, and forage sorghum. Further water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as pheasants. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil. Slope and seepage are limitations on sites for sewage lagoons. Some land shaping commonly is needed to overcome the slope. Seepage can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IVe, and the range site is Limy Upland.

Pm—Penden-Canlon loams, 7 to 20 percent slopes. These deep and shallow, strongly sloping and moderately steep soils are on side slopes dissected by deeply entrenched drainageways (fig. 7). The deep, well drained Penden soil is on the less sloping, upper side slopes. The shallow, somewhat excessively drained Canlon soil is on narrow side slopes above areas of rock outcrop. Individual areas are irregular in shape and range from 20 to 300 acres in size. They are about 60 percent Penden soil and 30 percent Canlon soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Penden soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 10 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 10 inches thick. The upper part of the substratum is pale brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam.

Typically, the Canlon soil has a surface layer of grayish brown, calcareous loam about 3 inches thick. The next layer is light brownish gray, calcareous loam about 3 inches thick. The substratum to a depth of about 12 inches is light brownish gray, calcareous very gravelly loam. White, hard caliche is at a depth of about 12 inches.

Included with these soils in mapping are small areas of Campus, Humbarger, and Uly soils and small areas of rock outcrop. The moderately deep Campus soils are on mid slopes between the Penden and Canlon soils. Humbarger soils are on flood plains. The silty Uly soils are on side slopes above the Penden and Canlon soils. The rock outcrop is on steep slopes below the Penden and Canlon soils. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Penden and Canlon soils, and surface runoff is rapid. Available water capacity is high in the Penden soil and low in the Canlon soil. Natural fertility is medium in the Penden soil and low in the Canlon soil. The surface layer of the Penden soil is mildly alkaline, and that of the Canlon soil is moderately alkaline. Root penetration is restricted by the bedrock at a depth of about 12 inches in the Canlon soil. The shrink-swell potential is moderate in the subsoil of the Penden soil.

Most areas are used as range. Because of the water erosion hazard on both soils and the shallowness to hard caliche in the Canlon soil, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. Little bluestem is more common on the shallow Canlon soil than on the Penden soil. If the range is used throughout the growing season, the dominent native grasses are replaced by less desirable grasses, such as buffalograss, hairy grama, and western wheatgrass. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing

Figure 7.—An area of Penden-Canlon loams, 7 to 20 percent slopes, dissected by a deeply entrenched drainageway. Yucca plants are common on these soils.

season, and a uniform distribution of grazing helps to keep the range productive.

The Penden soil is moderately well suited to dwellings and septic tank absorption fields. The slope is a limitation affecting both uses. Also, the shrink-swell potential is a limitation on sites for dwellings, and the moderate permeability is a limitation on sites for septic tank absorption fields. Buildings should be designed so that they conform to the natural slope of the land, and the lateral lines in septic tank absorption fields should be

installed on the contour. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil.

Because of slope and seepage, the Penden soil is poorly suited to sewage lagoons. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The Canlon soil is generally unsuited to building site development because of the slope and the depth to bedrock.

The land capability classification is VIe. The Penden soil is in the Limy Upland range site, and the Canlon soil is in the Shallow Limy range site.

Po—Penden-Uly complex, 7 to 20 percent slopes. These deep, strongly sloping and moderately steep, well drained soils are on side slopes. The landscape is dissected by deeply entrenched drainageways. The loamy Penden soil is on the less sloping, lower side slopes, and the silty Uly soil is on the steeper, upper side slopes. Individual areas are irregular in shape and range from 30 to several hundred acres in size. They are about 55 percent Penden soil and 35 percent Uly soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Penden soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsurface layer is grayish brown, calcareous clay loam about 10 inches thick. The subsoil is very pale brown, friable, calcareous clay loam about 10 inches thick. The upper part of the substratum is pale brown, calcareous clay loam. The lower part to a depth of about 60 inches is light yellowish brown, calcareous loam. In places caliche is at a depth of about 30 inches.

Typically, the Uly soil has a surface layer of grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Included with these soils in mapping are small areas of Humbarger soils on flood plains. These soils make up about 10 percent of the map unit.

Permeability is moderate in the Penden and Uly soils, and surface runoff is rapid. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer of the Penden soil is mildly alkaline, and that of the Uly soil is slightly acid. The shrink-swell potential is moderate in the subsoil of the Penden soil.

Most areas are used as range (fig. 8). Because of the hazard of water erosion, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, blue grama, and tall dropseed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

Mainly because of the slope, these soils are only moderately well suited to dwellings and septic tank absorption fields and are poorly suited to sewage lagoons. Buildings should be designed so that they conform to the natural slope of the land, and the lateral lines in septic tank absorption fields should be installed on the contour. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling of the Penden soil. The moderate permeability of this soil restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil.

The land capability classification is VIe. The Penden soil is in the Limy Upland range site, and the Uly soil is in the Loamy Upland range site.

Uc—Uly silt loam, 2 to 6 percent slopes. This deep, moderately sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is grayish brown silt loam about 12 inches thick (fig. 9). The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In some eroded areas the depth to lime is less than 10 inches.

Included with this soil in mapping are small areas of Holdrege and Penden soils. Holdrege soils have more clay in the subsoil than the Uly soil. They are in gently sloping areas above the Uly soil. The loamy Penden soils are on side slopes below the Uly soil. Included soils make up about 5 percent of the map unit.

Permeability and organic matter content are moderate in the Uly soil. Available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is slightly acid. It is friable and can be easily tilled throughout a wide range in moisture content.

Figure 8.—An area of the Penden-Uly complex, 7 to 20 percent slopes, used as range. Yucca plants are common on these soils.

About half of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

About half of the acreage is range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, blue grama, and tall dropseed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil is well suited to dwellings and septic tank absorption fields. It is only moderately well suited to sewage lagoons because of seepage and slope. Seepage can be controlled by sealing the floor and walls of the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Ud—Uly silt loam, 6 to 11 percent slopes. This deep, strongly sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to about 80 acres in size.

Typically, the surface layer is grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam. In some eroded areas the depth to lime is less than 10 inches.

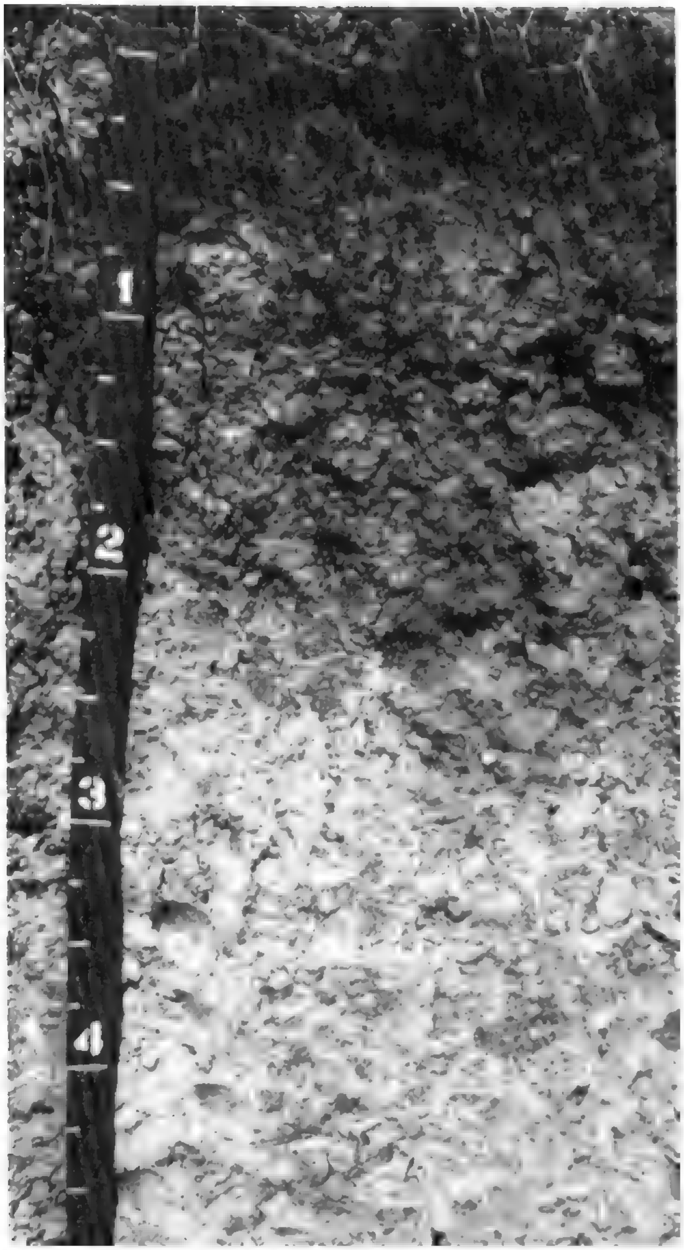

Figure 9.—Profile of Uly silt loam, 2 to 6 percent slopes. The dark surface layer extends to a depth of about 12 inches. Depth is marked in feet.

Included with this soil in mapping are small areas of the loamy Penden soils on the lower side slopes. These soils make up about 5 percent of the map unit.

Permeability and organic matter content are moderate in the Uly soil. Surface runoff is rapid. Available water capacity is high, and natural fertility is medium. The surface layer is slightly acid. It is friable and can be easily tilled throughout a fairly wide range in moisture content.

About half of the acreage is used for cultivated crops. This soil is poorly suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

About half of the acreage is range. Some formerly cultivated areas have been seeded to grasses. Range seeding is needed to restore the productivity of abandoned cropland. If the reestablished range is used throughout the growing season, the reseeded grasses are replaced by less desirable grasses, such as buffalograss and blue grama. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil commonly joins areas of contrasting land uses. The transition zone between cropland and range provides good habitat for upland wildlife, such as pheasants. Shrubs planted along the edge between cropland and range provide needed winter cover.

This soil is moderately well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons. The slope is a limitation affecting all of these uses. Also, seepage is a limitation on sites for sewage lagoons. Buildings should be designed so that they conform to the natural slope of the land, and the lateral lines in septic tank absorption fields should be installed on the contour. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction. Seepage can be controlled by sealing the floor and walls of the lagoon.

The land capability classification is IVe, and the range site is Loamy Upland.

Ue—Uly silt loam, 11 to 20 percent slopes. This deep, moderately steep, well drained soil is on side slopes. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is grayish brown silt loam about 12 inches thick. The subsoil is friable, calcareous silt loam about 16 inches thick. The upper part is brown, and the lower part is pale brown. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of the loamy Humbarger and Penden soils. Humbarger soils are on flood plains. Penden soils are on side slopes below the Uly soil. Included soils make up about 5 percent of the map unit.

Permeability and organic matter content are moderate in the Uly soil. Surface runoff is rapid. Available water capacity is high, and natural fertility is medium. The surface layer is slightly acid.

Most areas are used as range. Because of the hazard of water erosion, this soil is generally unsuited to cultivated crops. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, blue grama, and tall dropseed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

This soil is poorly suited to dwellings, septic tank absorption fields, and sewage lagoons. The slope is the main limitation. The less sloping included soils are better sites for these uses.

The land capability classification is VIe, and the range site is Loamy Upland.

Va—Valentine loamy sand, 3 to 9 percent slopes. This deep, rolling, excessively drained soil is on uplands. Individual areas range from 30 to 400 acres in size.

Typically, the surface layer is grayish brown loamy sand about 9 inches thick. The next layer is pale brown loamy sand about 7 inches thick. The substratum is calcareous. The upper part is light yellowish brown sand. The lower part to a depth of about 60 inches is very pale brown fine sand. In places the surface layer is calcareous.

Permeability is rapid, and surface runoff is slow. Available water capacity, organic matter content, and natural fertility are low. The surface layer is neutral.

Nearly all of the acreage is used as range. Because of the low available water capacity and the hazard of soil blowing, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly sand bluestem, little bluestem, and switchgrass. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, hairy grama, and blue grama. Soil blowing is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range productive.

This soil is well suited to dwellings; however, it is generally unsuited to septic tank absorption fields and sewage lagoons. It readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in the pollution of ground water. Seepage is a limitation on sites for sewage lagoons.

The land capability classification is VIe, and the range site is Sands.

Wn—Wakeen-Nibson silt loams, 3 to 8 percent slopes. These moderately sloping soils are on side slopes and ridgetops. The moderately deep, well drained Wakeen soil is on the upper side slopes and on ridgetops. The shallow, somewhat excessively drained Nibson soil is on the lower side slopes. Individual areas are irregular in shape and range from 20 to 120 acres in size. They are about 65 percent Wakeen soil and 20 percent Nibson soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Wakeen soil has a surface layer of dark grayish brown, calcareous silt loam about 12 inches thick. The subsoil is friable, calcareous silty clay loam about 21 inches thick. The upper part is pale brown, and the lower part is very pale brown. Chalky limestone and shale are at a depth of about 33 inches (fig. 10).

Typically, the Nibson soil has a surface layer of light brownish gray, calcareous silt loam about 6 inches thick. The subsoil is very pale brown, friable, calcareous silty clay loam about 5 inches thick. The substratum is white, calcareous silty clay loam about 7 inches thick. Chalky limestone and shale are at a depth of about 18 inches.

Included with these soils in mapping are small areas of Armo and Penden soils and small areas of weathered limestone and shale outcrops. The deep, loamy Armo soils are on foot slopes. The deep, loamy Penden soils are on side slopes above the Wakeen and Nibson soils. The outcrops are on side slopes. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Wakeen and Nibson soils, and surface runoff is medium. Available water capacity is moderate in the Wakeen soil and low in the Nibson soil. Organic matter content is low in both soils. Natural fertility is medium in the Wakeen soil and low in the Nibson soil. The surface layer of the Wakeen soil is mildly alkaline, and that of the Nibson soil is moderately alkaline. Root penetration is restricted by the bedrock at a depth of about 18 inches in the Nibson soil. The shrink-swell potential is moderate in the subsoil of both soils.

About half of the acreage is used for cultivated crops. These soils are poorly suited to wheat, grain sorghum, and forage sorghum. Yields are significantly reduced on the Nibson soil because of the low available water capacity and the shallowness to chalky limestone and shale. Water erosion is a hazard on both soils if cultivated crops are grown. Terraces, contour farming, grassed waterways, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop

Figure 10.—Profile of Wakeen silt loam, which is 20 to 40 inches deep over bedrock.

residue to the soil and adding other organic material improve tilth and fertility and increase the infiltration rate.

Much of the acreage is range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, switchgrass, and tall dropseed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

The Wakeen soil is moderately well suited to dwellings. It is poorly suited to septic tank absorption fields and sewage lagoons. The depth to bedrock is a limitation affecting all of these uses. Also, the shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. The deeper included soils are better suited to building site development than the Wakeen soil.

The Nibson soil is generally unsuited to building site development because of the depth to bedrock.

The land capability classification is IVe, and the range site is Limy Upland.

Ws—Wakeen-Nibson silt loams, 8 to 20 percent slopes. These strongly sloping and moderately steep soils are on side slopes dissected by deeply entrenched drainageways. The moderately deep, well drained Wakeen soil is on the upper side slopes. The shallow, somewhat excessively drained Nibson soil is on lower side slopes. Individual areas are irregular in shape and range from 30 to several hundred acres in size. They are about 55 percent Wakeen soil and 30 percent Nibson soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Wakeen soil has a surface layer of dark grayish brown, calcareous silt loam about 12 inches thick. The subsoil is friable, calcareous silty clay loam about 21 inches thick. The upper part is pale brown, and the lower part is very pale brown. Chalky limestone and shale are at a depth of about 33 inches.

Typically, the Nibson soil has a surface layer of light brownish gray, calcareous silt loam about 6 inches thick. The subsoil is very pale brown, friable, calcareous silty clay loam about 5 inches thick. The substratum is white, calcareous silty clay loam about 7 inches thick. Chalky limestone and shale are at a depth of about 18 inches.

Included with these soils in mapping are small areas of the deep, loamy Armo, Humbarger, and Penden soils. Armo soils are on foot slopes. Humbarger soils are on flood plains. Penden soils are on side slopes above the Wakeen and Nibson soils. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Wakeen and Nibson soils, and surface runoff is medium. Available water capacity is moderate in the Wakeen soil and low in the Nibson soil. Organic matter content is low in both soils. Natural fertility is medium in the Wakeen soil and low in the Nibson soil. The surface layer of the Wakeen soil is mildly alkaline, and that of the Nibson soil is moderately

alkaline. Root penetration is restricted by the bedrock at a depth of about 18 inches in the Nibson soil. The shrink-swell potential is moderate in the subsoil of both soils.

Most areas are used as range. Because of the hazard of water erosion on both soils and the shallowness to chalky limestone and shale bedrock in the Nibson soil, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. If the range is used throughout the growing season, these grasses are replaced by less desirable grasses, such as buffalograss, blue grama, and tall dropseed. Erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range productive.

The Wakeen soil is moderately well suited to dwellings. It is poorly suited to septic tank absorption fields and sewage lagoons. The depth to bedrock is a limitation affecting all of these uses. Also, the slope is a limitation on sites for dwellings and sewage lagoons, and the shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material help to prevent the structural damage caused by shrinking and swelling. Buildings should be designed so that they conform to the natural slope of the land. The deeper included soils are better suited to building site development than the Wakeen soil.

The Nibson soil is generally unsuited to building site development because of the slope and the depth to bedrock.

The land capability classification is VIe, and the range site is Limy Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 351,040 acres in the survey area, or nearly 61 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county. Almost all of the acreage in the Holdrege-Uly-Coly and Hord-Bridgeport-Munjor associations is prime farmland. About 65 percent of the acreage in the Holdrege-Uly-Penden association and 30 percent in the Uly-Penden-Wakeen association are prime farmland. The associations are described under the heading "General Soil Map Units." Most of the prime farmland is cropland, some of which is irrigated.

The map units in the survey area that are considered prime farmland are listed at the end of this section. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The map units that meet the soil requirements for prime farmland are:

An Anselmo sandy loam, 2 to 6 percent slopes
As Armo loam, 3 to 7 percent slopes
Br Bridgeport silt loam
Cn Coly silt loam, 2 to 6 percent slopes
Et Eltree silt loam, 1 to 3 percent slopes
Hf Holdrege silt loam, 0 to 1 percent slopes
Hg Holdrege silt loam, 1 to 3 percent slopes
Ho Hord silt loam
Hw Humbarger loam, occasionally flooded
Mu Munjor sandy loam, occasionally flooded
Ph Penden loam, 3 to 8 percent slopes
Uc Uly silt loam, 2 to 6 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to a capability classification and a range site at the end of each map unit description and in tables 5 and 6. The capability classification and range site for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops

Jerry B. Lee, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 336,000 acres in Graham County, or 58 percent of the total acreage, is used for cultivated crops or is summer fallowed. During the period 1971-81, wheat was grown on about 52 percent of the cropland, grain sorghum on 10 percent, and alfalfa or sunflowers on 4 percent (*3*). About 34 percent of the cropland was summer fallowed. The acreage used for wheat, corn, and summer fallow increased during this period compared to that of the previous 10-year period. The acreage used for grain sorghum decreased, and the acreage of all other crops remained the same.

Crop production can be increased on most farms by applying the latest technology. This soil survey can facilitate the application of such technology. The main concerns in managing the soils in Graham County for cultivated crops are controlling water erosion and soil blowing, making the most efficient use of the available water, and maintaining fertility and tilth.

Water erosion is the major hazard on about 70 percent of the cropland. It occurs mainly on soils that have a slope of more than 1 or 2 percent. Examples are Anselmo, Armo, Coly, Eltree, Holdrege, Penden, Uly, and Wakeen soils. Unless the surface is protected by a crop or crop residue, soil blowing is a hazard on some of the soils that have a sandy loam or loamy sand surface layer. Examples are Anselmo, Inavale, and Munjor soils.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the

surface layer is lost and part of the subsoil is incorporated into the plow layer. Secondly, erosion results in pollution of streams by sediments, nutrients, and pesticides. Control of erosion minimizes the pollution of streams and improves the quality of water.

Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods helps to control erosion and preserves the productive capacity of the soils.

Conservation tillage and conservation cropping systems help to control water erosion and soil blowing. A system of conservation tillage leaves all or part of the crop residue on the surface. Examples are stubble mulching and chemical fallow. When these systems are applied, the stubble of crops or crop residue is left essentially in place to provide a protective cover before and during the preparation of a seedbed and at least a partial cover for the succeeding crop. Drilled crops, such as small grain, are alternated with row crops in a conservation cropping system. Wind stripcropping, or the production of crops in relatively narrow strips perpendicular to the direction of the prevailing winds, is also used in conservation cropping systems to help control soil blowing.

Terraces, diversions, grassed waterways, and contour farming are needed in combination with conservation tillage on soils that have a slope of more than 2 percent. If a system of conservation tillage is not applied, they also are needed on soils that have a slope of more than 1 percent. Terraces and diversions help to control erosion by shortening the length of slopes and reducing the runoff rate. They are most practical on deep, well drained soils that have uniform slopes. Contour farming should generally be used in combination with terraces. It is best suited to soils that have smooth, uniform slopes and are suitable for terracing.

Inadequate rainfall usually is a problem on all of the cropland in the county. As a result, the supply of water stored in the soil should to be conserved or increased by summer fallowing and terracing. Summer fallowing allows the soil to store moisture during the summer for the growth of succeeding crops. Most of the fallowed cropland in the county is in a wheat-sorghum-fallow or wheat-fallow-wheat rotation. Summer fallowing is most effective when the crop residue is managed by stubble mulching or by chemical fallow. Stubble mulch is effective in trapping snow. Both stubble mulching and terracing reduce the runoff rate.

Organic matter is a storehouse of available plant nutrients. It increases the rate of water intake, helps to prevent surface crusting, helps to control erosion, and improves tilth. Most of the soils in the county that are used for crops have a silt loam surface layer. A surface crust forms during periods of intensive rainfall. When dry, the crusted surface is nearly impervious to water. As a result, the runoff rate is increased. Regularly adding organic material and leaving crop residue on the surface help to prevent excessive crusting, increase the rate of water infiltration, and reduce the runoff rate and the hazard of erosion.

Plants on most of the arable soils in the county respond well to applications of nitrate and phosphate fertilizers. On all soils the amount of fertilizer to be applied should be based on the results of soil tests, on the needs of the crop, on the expected level of yields, and on the experience of farmers. The Cooperative Extension Service can help to determine the kind and amount of fertilizer needed.

Information about the design of erosion-control practices is available in the local office of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units," in the yields table, and in the section "Interpretive Groups."

Rangeland

Loren J. Pearson, range conservationist, Soil Conservation Service, helped prepare this section.

About 223,000 acres in Graham County, or nearly 39 percent of the total acreage, is range (fig. 11). Areas of range are throughout the county, generally adjacent to drainageways and on the steeper slopes that cannot be easily farmed. About 36,000 head of livestock utilize the range resource each year (*3*). Cow-calf enterprises are dominant, but some ranchers have stocker enterprises. Also, several hundred head are full-fed each year. The native range is well suited to these livestock enterprises.

The grass species in the areas of range are essentially the same as those of 100 years ago. Changes in the plant community result from environmental changes or cultural influences. Proper grazing management can improve the range grasses and increase productivity.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and

Figure 11.—An area of Humbarger soils used as range. Campus and Canlon soils are in the background.

unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be

used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Nearly all of the livestock management programs in the county rely on native range for summer grazing from mid-May through late in October. In mid-August the protein levels of native grasses begin to drop below the daily requirements of the livestock. Protein supplements are needed during this period. A scheduled deferment of grazing during the growing season allows the plants to gain vigor. Numerous variations of this system can be used in nearly every livestock program.

Native Woodland, Windbreaks, and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

The native woodland in Graham County is in upland drainageways and along the major streams and rivers in areas of the Hord-Bridgeport-Munjor association. The wooded areas occur only as narrow bands or strips. Eastern cottonwood and peachleaf willow are the dominant species along the South Fork of the Solomon River. The dominant species along Bow Creek are boxelder, green ash, American elm, and peachleaf willow. In areas along this creek, eastern cottonwood is more prevalent in the eastern part of the county than in the western part. Other associated species include red mulberry, hackberry, black walnut, honeylocust, American plum, and golden currant. The understory is mainly green ash, hackberry, and boxelder.

Upland drainageways support trees mostly in their lower reaches. Eastern cottonwood and peachleaf willow are the dominant species. Other species include green ash, boxelder, red mulberry, American elm, honeylocust, American plum, Siberian elm, and golden currant.

Trees in the wooded areas can be used for firewood and other wood products, but they are in scattered areas and do not make up large enough concentrations to be of commercial value.

Trees grow on most of the farmsteads and ranch headquarters in Graham County. Some are windbreaks, but most are environmental or ornamental plantings. Only a few shelterbelts and field windbreaks are grown in the county (fig. 12). Windbreaks that protect livestock are numerous. They are an important part of the livestock industry.

The dominant species in old plantings generally are eastern redcedar and Siberian elm. In areas of the Hord-Bridgeport-Munjor association, however, eastern cottonwood was planted extensively. New windbreaks consist mainly of eastern redcedar, Rocky Mountain juniper, honeylocust, and lilac. Other commonly planted species are ponderosa pine, Austrian pine, Scotch pine, cotoneaster, Russian-olive, tamarisk, green ash, hackberry, Russian mulberry, and oriental arborvitae.

Tree planting is a continual need because old trees pass maturity and deteriorate, because some trees are destroyed by insects, disease, or storms, and because new plantings are needed on expanding farmsteads. Renovation measures, such as removal and replacement or supplemental planting, help to maintain the effectiveness of the windbreak.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the trees and shrubs selected for planting. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate.

Establishing trees and shrubs is difficult in Graham County. The moisture supply is normally short during the growing season, and hot, drying winds are common. Unsuccessful windbreaks and environmental plantings result mainly from dry conditions and competition from weeds and grasses. Proper site preparation before planting and control of competing vegetation after planting are important concerns in establishing and maintaining a windbreak. Supplemental watering is needed during dry periods, and cover crops are needed to protect the surface from hot winds.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting

Figure 12.—A field windbreak in an area of Holdrege silt loam, 1 to 3 percent slopes.

stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Graham County has several areas of scenic, geologic, and historic interest. Scenic views of cropland, rolling grassland, and rocky bluffs are available throughout the county. The pheasant hunting season draws many hunters to this part of the state.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a

site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Graham County are pheasant, bobwhite quail, cottontail rabbit, white-tailed deer, and mule deer. Mourning doves, fox squirrels, prairie chickens, and turkeys are hunted on a limited basis. Some coyotes, raccoons, and opossum are trapped in the county. Coyote hunting with dogs is also popular.

Nongame species are numerous because of the diversity of habitat types in the county. Cropland, woodland, and grassland are intermixed throughout the county. This intermixture creates the desirable edge effect conducive to a variety of wildlife species. Establishing additional fringe areas generally increases the wildlife population. A good windbreak can provide winter cover for several pheasants and cottontails, a covey of quail, and many songbirds.

Fishing is limited to a few farm ponds where channel catfish, bullheads, bass, and bluegill can be caught.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are grain sorghum, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, wheatgrass, grama, switchgrass, sunflowers, and ragweed.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are sand sagebrush, sandbar willow, plum, prairie rose, smooth sumac, and fragrant sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, and cottontail.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include meadowlark, prairie chicken, hawks, prairie dogs, and mule deer.

Technical assistance in planning wildlife areas and in determining the vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

John Eberwein, civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about

kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock or a very firm dense layer, stone content, soil texture, and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil

through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope and bedrock can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil

after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5

feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

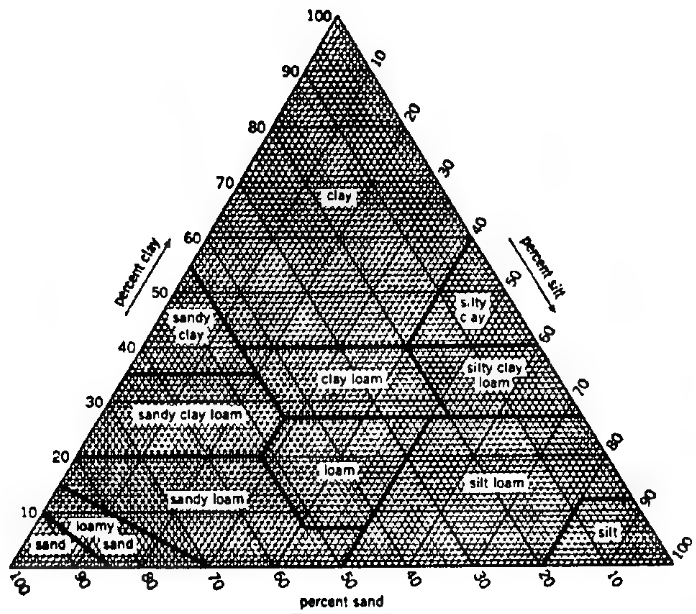

Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in

group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type

of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or

soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiustolls (*Argi*, meaning argillic horizon, plus *ustoll*, the suborder of the Mollisols that have an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-silty, mixed, mesic Typic Argiustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Anselmo Series

The Anselmo series consists of deep, well drained, moderately rapidly permeable soils on uplands. These soils formed in loamy and sandy eolian material. Slopes range from 2 to 6 percent.

Anselmo soils are commonly adjacent to Munjor and Valentine soils. The adjacent soils do not have a mollic epipedon or a B horizon. The calcareous Munjor soils are on flood plains. The sandy Valentine soils are in positions on the landscape similar to those of the Anselmo soils.

Typical pedon of Anselmo sandy loam, 2 to 6 percent slopes, 1,500 feet south and 400 feet east of the northwest corner of sec. 11, T. 8 S., R. 21 W.

Ap—0 to 10 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; many fine tubular pores; neutral; gradual smooth boundary.

Bw—10 to 26 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) moist; dark coatings on faces of peds; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; many fine roots; about 3 percent fine quartz pebbles; neutral; gradual smooth boundary.

C—26 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand, brown (10YR 5/3) moist; weak fine granular structure; slightly hard, very friable; about 3 percent fine quartz pebbles; mildly alkaline.

The thickness of the solum ranges from 11 to 40 inches. The depth to free carbonates ranges from 26 to more than 60 inches. The mollic epipedon is from 7 to 20 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is typically sandy loam, but the range includes fine sandy loam and loamy fine sand. The Bw horizon has hue of 10YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. It is fine sandy loam or loam. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loamy fine sand or fine sand. It is mildly alkaline or moderately alkaline. Some pedons have strata of material reworked by the wind.

Armo Series

The Armo series consists of deep, well drained, moderately permeable soils on upland foot slopes. These soils formed in calcareous, loamy and silty colluvium weathered from chalky limestone. Slopes range from 3 to 7 percent.

Armo soils are commonly adjacent to Eltree, Nibson, and Wakeen soils. Eltree soils have a mollic epipedon that is more than 20 inches thick and are lower in content of chalk fragments than the Armo soils. Also, they are lower on the landscape. The shallow Nibson soils are on side slopes. The moderately deep Wakeen soils are higher on the landscape than the Armo soils.

Typical pedon of Armo loam, 3 to 7 percent slopes, 900 feet east and 200 feet south of the northwest corner of sec. 36, T. 10 S., R. 21 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

A—6 to 15 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

AB—15 to 18 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

Bw—18 to 31 inches; light brownish gray (10YR 6/2) clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

BCk—31 to 46 inches; very pale brown (10YR 7/3) clay loam, pale brown (10YR 6/3) moist; weak fine subangular blocky structure; slightly hard, friable; common carbonate accumulations; few limestone fragments; violent effervescence; moderately alkaline; clear smooth boundary.

C—46 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; about 5 percent chalky shale fragments; few lime threads; violent effervescence; moderately alkaline.

The mollic epipedon ranges from 7 to 20 inches in thickness. The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but in some pedons it is silt loam. It is mildly alkaline or moderately alkaline. The B horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is clay loam, silty clay loam, or loam. It is mildly alkaline or moderately alkaline. The C horizon has colors similar to those of the B horizon. It is silt loam or clay loam. It is moderately alkaline or strongly alkaline. The content of chalk fragments 0.5 millimeter to 1 inch in diameter ranges from 0 to 10 percent in this horizon.

Bridgeport Series

The Bridgeport series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in calcareous, silty alluvium. Slopes range from 0 to 2 percent.

Bridgeport soils are similar to Hord soils and are commonly adjacent to Inavale and Munjor soils. Hord soils have a mollic epipedon that is more than 20 inches thick and are on stream terraces. Inavale and Munjor soils contain more sand than the Bridgeport soils, do not have a mollic epipedon, and are on flood plains.

Typical pedon of Bridgeport silt loam, 1,100 feet east and 25 feet south of the northwest corner of sec. 16, T. 8 S., R. 21 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; few fine roots; few fine tubular pores; slight effervescence; moderately alkaline; gradual smooth boundary.
A—6 to 18 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; few fine tubular pores; slight effervescence; moderately alkaline; gradual smooth boundary.
Bw—18 to 35 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few fine tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.
C—35 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; hard, friable; few very fine roots; stratified with thin bands of fine sandy loam; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 10 to 35 inches. The mollic epipedon ranges from 10 to 20 inches in thickness and extends into the Bw horizon. The depth to carbonates ranges from 0 to 15 inches. Thin strata that vary in color and in content of clay and sand are below the mollic epipedon.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is typically silt loam, but the range includes loam and fine sandy loam. This horizon ranges from neutral to moderately alkaline. The Bw horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is typically silt loam, but the range includes silty clay loam and loam. This horizon is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is silt loam or loam. It is mildly alkaline or moderately alkaline.

Campus Series

The Campus series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, loamy material weathered from sandstone or caliche. Slopes range from 6 to 15 percent.

Campus soils are similar to Penden soils and are commonly adjacent to Canlon, Penden, and Wakeen soils. The shallow Canlon soils are on the steeper side slopes below the Campus soils. The deep Penden soils are higher on the landscape than the Campus soils. The silty Wakeen soils are lower on the landscape than the Campus soils.

Typical pedon of Campus loam, in an area of Campus-Canlon loams, 6 to 30 percent slopes, 350 feet north and 50 feet east of the southwest corner of sec. 13, T. 6 S., R. 21 W.

A1—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; many fine roots; few fine caliche fragments; strong effervescence; moderately alkaline; clear smooth boundary.
A2—8 to 15 inches; gray (10YR 5/1) loam, very dark grayish brown (10YR 3/2) moist; moderate fine and medium granular structure; slightly hard, friable; common fine caliche fragments; violent effervescence; moderately alkaline; clear wavy boundary.
Bw—15 to 24 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate medium granular structure; hard, firm; common fine roots; many medium caliche fragments; violent effervescence; moderately alkaline; clear wavy boundary.
BCk—24 to 30 inches; white (10YR 8/2) loam, light brownish gray (10YR 6/2) moist; massive; hard, firm; few fine roots; soft powdery lime; many medium caliche fragments; violent effervescence; moderately alkaline; clear smooth boundary.
R—30 inches; white hard caliche.

The mollic epipedon ranges from 7 to 20 inches in thickness. The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but the range includes clay loam and silty clay loam. This horizon is mildly alkaline or moderately alkaline. The B horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 to 4. It is loam or clay loam. It is mildly alkaline or moderately alkaline. The content of coarse fragments is about 20 percent in the BC horizon.

Canlon Series

The Canlon series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in loamy material weathered from limy sandstone or caliche. Slopes range from 6 to 30 percent.

Canlon soils are commonly adjacent to Campus, Penden, and Wakeen soils. The moderately deep Campus soils are on side slopes above the Canlon soils. The deep Penden soils are higher on the landscape than the Canlon soils. The silty, moderately deep Wakeen soils are lower on the landscape than the Canlon soils.

Typical pedon of Canlon loam, in an area of Campus-Canlon loams, 6 to 30 percent slopes, 590 feet east and 820 feet south of the northwest corner of sec. 12, T. 9 S., R. 23 W.

A—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine tubular roots; violent effervescence; moderately alkaline; clear smooth boundary.
AC—3 to 6 inches; light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; hard, friable; many fine tubular roots; strong effervescence; moderately alkaline; clear smooth boundary.
C—6 to 12 inches; light brownish gray (10YR 6/2) gravelly loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; few fine tubular roots; about 50 percent calcium carbonate fragments (mostly caliche) 2 millimeters to 3 inches in diameter; violent effervescence; moderately alkaline; abrupt smooth boundary.
R—12 inches; unweathered bedrock; white hard caliche.

The thickness of the solum ranges from 3 to 12 inches. The depth to bedrock ranges from 10 to 20 inches. The content of caliche fragments less than 3 inches in diameter is about 33 percent throughout the profile. These soils are mildly alkaline or moderately alkaline throughout.

The A horizon has hue of 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 2 or 3. The C horizon has hue of 10YR, value of 6 to 8 (4 to 7 moist), and chroma 2 to 4.

Coly Series

The Coly series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 11 percent.

Coly soils are similar to Uly soils and are commonly adjacent to Holdrege, Hord, Penden, and Uly soils. The adjacent soils have a mollic epipedon. Holdrege soils are higher on the landscape than the Coly soils. Hord soils are on terraces along drainageways and small streams. Penden soils are on side slopes below the Coly soils. Uly soils are in positions on the landscape similar to those of the Coly soils.

Typical pedon of Coly silt loam, 2 to 6 percent slopes, 1,220 feet east and 110 feet north of the southwest corner of sec. 5, T. 10 S., R. 25 W.

Ap—0 to 6 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak medium granular structure; slightly hard, friable; many fine roots; many tubular pores; strong effervescence; moderately alkaline; clear smooth boundary.
AC—6 to 13 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; weak medium granular structure; slightly hard, friable; few very fine roots; many fine tubular pores; many soft lime masses; strong effervescence; moderately alkaline; clear smooth boundary.
C—13 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; soft, very friable; few lime threads; few fine tubular pores; strong effervescence; moderately alkaline.

Typically, free carbonates are at the surface, but some pedons do not have carbonates in the upper 3 inches. The A horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline. The AC and C horizons have hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. They have visible films, masses, and threads of carbonates.

Eltree Series

The Eltree series consists of deep, well drained, moderately permeable soils on foot slopes in the uplands. These soils formed in calcareous, loamy colluvium weathered from chalky limestone. Slopes range from 1 to 3 percent.

Eltree soils are similar to Holdrege soils and are commonly adjacent to Armo, Hord, and Nibson soils. Armo and Holdrege soils have a mollic epipedon that is less than 20 inches thick. They are higher on the landscape than the Eltree soils. Hord soils do not have carbonates within 20 inches of the surface. They are on stream terraces. The shallow Nibson soils are on side slopes above the Eltree soils.

Typical pedon of Eltree silt loam, 1 to 3 percent slopes, 1,100 feet north and 200 feet west of the southeast corner of sec. 26, T. 10 S., R. 22 W.

Ap—0 to 9 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.
A—9 to 21 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.
AB—21 to 25 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; few fine roots; many fine pores; strong effervescence; moderately alkaline; gradual smooth boundary.
Bw—25 to 40 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few fine pores; few fine lime nodules; few fine chalk fragments; strong effervescence; moderately alkaline; gradual smooth boundary.
BC—40 to 45 inches; very pale brown (10YR 7/4) silt loam, yellowish brown (10YR 5/4) moist; weak fine

subangular blocky structure; slightly hard, friable; many small chalk fragments; common fine carbonate accumulations; violent effervescence; moderately alkaline; gradual smooth boundary.

C—45 to 60 inches; very pale brown (10YR 7/4) silt loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, friable; many fine carbonate accumulations; violent effervescence; moderately alkaline.

The thickness of the mollic epipedon ranges from 20 to 40 inches. The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silt loam, but in some pedons it is silty clay loam. It is mildly alkaline or moderately alkaline. The B horizon has hue of 10YR, value of 6 or 7 (4 or 5 moist), and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon has hue of 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 2 to 4.

Holdrege Series

The Holdrege series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 0 to 3 percent.

Holdrege soils are similar to Eltree and Uly soils and commonly are adjacent to Coly, Hord, and Uly soils. Eltree and Hord soils have a mollic epipedon that is more than 20 inches thick. Eltree soils are on foot slopes, and Hord soils are on stream terraces. Coly and Uly soils have less clay in the subsoil than the Holdrege soils. They are on side slopes below the Holdrege soils. Also, Coly soils do not have a mollic epipedon.

Typical pedon of Holdrege silt loam, 1 to 3 percent slopes, 200 feet west and 100 feet south of the northeast corner of sec. 35, T. 8 S., R. 21 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

A—6 to 13 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; mildly alkaline; clear smooth boundary.

Bt—13 to 22 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; moderate medium subangular blocky structure; slightly hard, firm; common fine roots; mildly alkaline; clear smooth boundary.

BC—22 to 27 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; moderately alkaline; clear smooth boundary.

C—27 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; soft, friable; many lime threads; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 38 inches. The mollic epipedon is 10 to 20 inches thick. The depth to free carbonates ranges from 18 to 32 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is typically silt loam, but in some pedons it is silty clay loam. It is neutral to medium acid. The Bt horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is neutral or mildly alkaline. The C horizon has hue of 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 3 or 4. It is mildly alkaline or moderately alkaline.

Hord Series

The Hord series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in a mixture of loess and alluvium. Slopes range from 0 to 2 percent.

Hord soils are similar to Bridgeport soils and are commonly adjacent to Coly, Eltree, Humbarger, and Uly soils. Bridgeport, Coly, Eltree, and Humbarger soils are shallower to calcareous material than the Hord soils. Bridgeport soils are on the lower terraces along the larger streams. Coly soils are on side slopes. Eltree soils are on foot slopes above the Hord soils. Humbarger soils are loamy in the subsoil. They are on flood plains. Uly soils have a mollic epipedon that is less than 20 inches thick. They are on side slopes above the Hord soils.

Typical pedon of Hord silt loam, 1,320 feet east and 630 feet north of the southwest corner of sec. 8, T. 10 S., R. 25 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; many fine tubular pores; neutral; clear smooth boundary.

A—8 to 13 inches; dark gray (10YR 4/1) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; many fine tubular pores; neutral; clear smooth boundary.

Bw—13 to 34 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; many fine tubular pores; neutral; clear smooth boundary.

BC—34 to 41 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; many fine tubular pores; many lime threads; strong effervescence; moderately alkaline; clear smooth boundary.

C—41 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; soft, friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 24 to 60 inches. The mollic epipedon ranges from 20 to 40 inches in thickness and extends into the Bw horizon. The depth to carbonates ranges from 20 to 48 inches. Typically, the C horizon contains free carbonates.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silt loam, but the range includes fine sandy loam and silty clay loam. This horizon ranges from medium acid to neutral. The B horizon has a range of color similar to that of the A horizon. It is silt loam or silty clay loam. It is slightly acid or neutral. The BC horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is mildly alkaline or moderately alkaline. The content of clay in the B and BC horizons averages about 25 percent, but ranges from 20 to 35 percent. The C horizon has hue of 10YR, value of 4 to 7 (3 to 5 moist), and chroma of 2 or 3. It ranges from fine sandy loam to silty clay loam. It is mildly alkaline or moderately alkaline.

Humbarger Series

The Humbarger series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in calcareous, loamy alluvium. Slopes range from 0 to 2 percent.

Humbarger soils are commonly adjacent to Penden and Wakeen soils. The adjacent soils are on uplands and have a mollic epipedon that is less than 20 inches thick. Also, Wakeen soils are moderately deep over bedrock.

Typical pedon of Humbarger loam, occasionally flooded, 1,750 feet south and 600 feet west of the northeast corner of sec. 10, T. 10 S., R. 22 W.

A—0 to 21 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, friable; many fine roots; many tubular pores; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—21 to 31 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium subangular blocky structure; slightly hard, friable; common fine roots; many fine tubular pores; common very fine lime pebbles; violent effervescence; moderately alkaline; gradual smooth boundary.

C—31 to 60 inches; grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 40 inches. The thickness of the mollic epipedon ranges from 20 to 30 inches. Most pedons are calcareous at the surface, but some do not have visible lime in the upper 10 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically loam or clay loam, but the range includes silt loam. This horizon is mildly alkaline or moderately alkaline. The AC horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam or clay loam, but the range includes silty clay loam and sandy loam. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is loam, sandy loam, or clay loam.

Inavale Series

The Inavale series consists of deep, excessively drained, rapidly permeable soils on flood plains. These soils formed in sandy alluvium. Slopes range from 0 to 9 percent.

Inavale soils are similar to Valentine soils and are commonly adjacent to Bridgeport and Munjor soils. Valentine soils are on uplands. The silty Bridgeport soils have a mollic epipedon. They are on stream terraces. Munjor soils are less sandy than the Inavale soils. They are are in landscape positions similar to those of the Inavale soils or are lower on the landscape.

Typical pedon of Inavale loamy sand, occasionally flooded, 110 feet east and 500 feet south of the northwest corner of sec. 12, T. 8 S., R. 21 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) loamy sand, dark brown (10YR 4/3) moist; single grained; soft, very friable; many very fine roots; slight effervescence; mildly alkaline; clear smooth boundary.

AC—6 to 10 inches; pale brown (10YR 6/3) sand, brown (10YR 5/3) moist; single grained; soft, very friable; common very fine roots; slight effervescence; mildly alkaline; gradual smooth boundary.

C—10 to 60 inches; very pale brown (10YR 7/3) sand, pale brown (10YR 6/3) moist; single grained; soft, very friable; few thin strata of fine sandy loam; few very fine roots in the upper part; slight effervescence; mildly alkaline.

Reaction ranges from neutral to moderately alkaline throughout the profile. The A horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is loamy sand or sand. The AC and C horizons have hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. They are dominantly loamy fine sand, loamy sand, or sand. In some pedons, however, the C horizon has strata of finer or coarser textured material.

Munjor Series

The Munjor series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in calcareous, loamy and sandy alluvium. Slopes range from 0 to 2 percent.

Munjor soils are commonly adjacent to Anselmo, Bridgeport, and Inavale soils. Anselmo and Bridgeport soils have a mollic epipedon. Anselmo soils are on upland side slopes. The silty Bridgeport soils are on stream terraces. Inavale soils are sandy. They are in landscape positions similar to those of the Munjor soils or are slightly higher on the landscape.

Typical pedon of Munjor sandy loam, occasionally flooded, 1,350 feet south and 100 feet west of the northeast corner of sec. 11, T. 8 S., R. 21 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; common very fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

C1—6 to 11 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 4/3) moist; single grained; soft, very friable; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C2—11 to 25 inches; light brownish gray (10YR 6/2) fine sandy loam, grayish brown (10YR 5/2) moist; massive; slightly hard, friable; strong effervescence; moderately alkaline; clear smooth boundary.

2C3—25 to 60 inches; light gray (10YR 7/2) sand, pale brown (10YR 6/3) moist; single grained; loose; strong effervescence; moderately alkaline.

Some pedons are noncalcareous within a depth of 10 inches. The A horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 1 to 3. It is typically sandy loam, but the range includes loam and fine sandy loam. This horizon is mildly alkaline or moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is sand, loamy sand, sandy loam, fine sandy loam, or loam.

Nibson Series

The Nibson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in loamy material weathered from interbedded chalky shale and soft limestone. Slopes range from 3 to 20 percent.

The surface layer of these soils has a slightly lighter color than is definitive for the Nibson series. This difference, however, does not alter the usefulness or behavior of the soils.

Nibson soils are commonly adjacent to Armo, Eltree, and Wakeen soils. The deep Armo and Eltree soils are on foot slopes below the Nibson soils. The moderately deep Wakeen soils are on side slopes above the Nibson soils.

Typical pedon of Nibson silt loam, in an area of Wakeen-Nibson silt loams, 3 to 8 percent slopes, about 2,490 feet north and 75 feet west of the southeast corner of sec. 33, T. 8 S., R. 21 W.

Ap—0 to 6 inches; light brownish gray (10YR 6/2) silt loam, grayish brown (10YR 5/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; few fine pores; strong effervescence; moderately alkaline; clear smooth boundary.

Bw—6 to 11 inches; very pale brown (10YR 7/3) silty clay loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable; common fine roots; few fine lime fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C—11 to 14 inches; white (10YR 8/2) silty clay loam, very pale brown (10YR 7/3) moist; massive; slightly hard, friable; few fine roots; many lime fragments; violent effervescence; strongly alkaline; clear smooth boundary.

Cr—14 to 18 inches; chalky limestone and shale.

The depth to weathered, chalky shale and soft limestone ranges from 10 to 20 inches. The A horizon has hue of 10YR or 2.5Y, value of 3 to 6 (2 to 5 moist), and chroma of 1 or 2. It ranges from mildly alkaline to strongly alkaline. The Bw and C horizons are silt loam or silty clay loam. They are moderately alkaline or strongly alkaline. The Bw horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. The C horizon has hue of 10YR or 2.5Y, value of 6 to 8 (5 to 7 moist), and chroma of 2 to 4.

Penden Series

The Penden series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in calcareous, loamy sediments. Slopes range from 3 to 15 percent.

Penden soils are similar to Campus soils and are commonly adjacent to Campus, Coly, Humbarger, and Uly soils. The moderately deep Campus soils are lower on the landscape than the Penden soils. Coly soils do not have a mollic epipedon. They are on side slopes above the Penden soils. Humbarger soils have a mollic epipedon that is more than 20 inches thick. They are on flood plains. The silty Uly soils are on side slopes above the Penden soils.

Typical pedon of Penden loam, 3 to 8 percent slopes, 158 feet west and 590 feet south of the northeast corner of sec. 24, T. 9 S., R. 21 W.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; hard, friable; common fine roots; mildly alkaline; clear smooth boundary.

A2—7 to 17 inches; grayish brown (10YR 5/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; hard, friable; common fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

Bk—17 to 27 inches; very pale brown (10YR 7/3) and light gray (10YR 7/2) clay loam, grayish brown (10YR 5/2) moist; weak coarse subangular blocky structure; hard, friable; common fine roots; few worm casts and many lime concretions; violent effervescence; moderately alkaline; gradual smooth boundary.

C1—27 to 53 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; massive; hard, friable; common fine roots; many coarse lime concentrations and few medium lime concretions; violent effervescence; moderately alkaline; clear smooth boundary.

C2—53 to 60 inches; light yellowish brown (10YR 6/4) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable; strong effervescence; moderately alkaline.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is typically loam, but the range includes clay loam and silty clay loam. This horizon is mildly alkaline or moderately alkaline. The Bk horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 5 moist), and chroma of 2 or 3. It is clay loam or loam. It is mildly alkaline or moderately alkaline. The C horizon has hue of 7.5YR or 10YR, value of 5 to 8 (4 to 7 moist), and chroma of 2 to 4. It is clay loam or loam.

Uly Series

The Uly series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 20 percent.

Uly soils are similar to Coly and Holdrege soils and are commonly adjacent to Coly, Holdrege, Hord, and Penden soils. Coly soils do not have a mollic epipedon. They are in positions on the landscape similar to those of the Uly soils. Holdrege soils have an argillic horizon. They are on ridgetops and gently sloping side slopes above the Uly soils. Hord soils have a mollic epipedon that is more than 20 inches thick. They are on terraces along small, intermittent streams. Penden soils have carbonates at the surface and have more sand in the subsoil than the Uly soils. They are in landscape positions similar to those of the Uly soils or are lower on the landscape.

Typical pedon of Uly silt loam, 2 to 6 percent slopes, 400 feet north and 400 feet east of the southwest corner of sec. 29, T. 8 S., R. 23 W.

A—0 to 12 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; many fine tubular pores; mildly alkaline; clear smooth boundary.

Bw—12 to 23 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; slightly hard, friable; many fine roots; many tubular pores; slight effervescence; mildly alkaline; clear smooth boundary.

BC—23 to 28 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few fine tubular pores; common lime threads; strong effervescence; moderately alkaline; clear smooth boundary.

C—28 to 60 inches; very pale brown (10YR 7/3) silt loam, pale brown (10YR 6/3) moist; massive; soft, very friable; many lime threads and soft lime masses; violent effervescence; moderately alkaline.

The solum ranges from 12 to 36 inches in thickness. The mollic epipedon is 7 to 16 inches thick. The depth to free carbonates ranges from 8 to 20 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2. It is typically silt loam, but in some pedons it is very fine sandy loam. It ranges from slightly acid to mildly alkaline. The B horizon has hue of 10YR, value of 4 to 7 (2 to 5 moist), and chroma of 2 or 3. It is typically silt loam, but in some pedons it is silty clay loam. It is mildly alkaline or moderately alkaline. In some pedons the lower part of the B horizon has an accumulation of carbonates. The C horizon has hue of 10YR or 7.5Y, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 4.

Valentine Series

The Valentine series consists of deep, excessively drained, rapidly permeable soils on uplands. These soils formed in sandy eolian material. Slopes range from 3 to 9 percent.

Valentine soils are similar to Inavale soils and are commonly adjacent to Anselmo, Campus, and Canlon soils. Inavale soils are on flood plains. Anselmo soils are loamy in the subsoil and have a mollic epipedon. They are in positions on the landscape similar to those of the Valentine soils. The moderately deep Campus and shallow Canlon soils are loamy throughout. They are on the steeper slopes above the Valentine soils.

Typical pedon of Valentine loamy sand, 3 to 9 percent slopes, 1,300 feet west and 150 feet north of the southeast corner of sec. 23, T. 7 S., R. 22 W.

A—0 to 9 inches; grayish brown (10YR 5/2) loamy sand, very dark grayish brown (10YR 3/2) moist; weak fine

granular structure parting to single grained; loose; many very fine and few fine roots; neutral; clear smooth boundary.

AC—9 to 16 inches; pale brown (10YR 6/3) loamy sand, brown (10YR 4/3) moist; weak fine granular structure parting to single grained; loose; common very fine roots; mildly alkaline; clear smooth boundary.

C1—16 to 27 inches; light yellowish brown (10YR 6/4) sand, dark yellowish brown (10YR 4/4) moist; single grained; loose; slight effervescence; mildly alkaline; clear smooth boundary.

C2—27 to 60 inches; very pale brown (10YR 7/3) fine sand, brown (10YR 5/3) moist; dark strata; single grained; loose; slight effervescence; moderately alkaline.

These soils are loamy sand, fine sand, or sand throughout. The A horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2. It is slightly acid or neutral. The AC horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is neutral or mildly alkaline. The C horizon has hue of 10YR, value of 6 or 7 (5 or 6 moist), and chroma of 2 to 4. It is neutral to moderately alkaline. In some pedons dark, loamy strata 1/8 to 1 inch thick are below a depth of about 40 inches.

Wakeen Series

The Wakeen series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from chalky limestone and shale. Slopes range from 3 to 20 percent.

Wakeen soils are commonly adjacent to Campus, Canlon, Humbarger, and Nibson soils. Campus and Canlon soils contain more sand in the subsoil than the Wakeen soils. Also, they are higher on the landscape. Humbarger soils have a mollic epipedon that is more than 20 inches thick. They are on flood plains. The shallow Nibson soils are on side slopes below the Wakeen soils.

Typical pedon of Wakeen silt loam, in an area of Wakeen-Nibson silt loams, 8 to 20 percent slopes, about 2,200 feet west and 2,200 feet north of the southeast corner of sec. 34, T. 8 S., R. 21 W.

A—0 to 12 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; strong effervescence; mildly alkaline; clear smooth boundary.

Bw—12 to 18 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; weak medium subangular blocky structure; slightly hard, friable; many fine roots; many fine pores; few lime pebbles; strong effervescence; moderately alkaline; clear smooth boundary.

BC—18 to 33 inches; very pale brown (10YR 7/3) silty clay loam, light yellowish brown (10YR 6/4) moist; weak fine granular structure; slightly hard, friable; violent effervescence; moderately alkaline; clear smooth boundary.

Cr—33 inches; very pale brown (10YR 7/3) chalky limestone and shale.

The thickness of solum and the depth to chalky shale range from 20 to 40 inches. The mollic epipedon ranges from 7 to 20 inches in thickness. These soils contain lime throughout.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is silt loam or silty clay loam. It is mildly alkaline or moderately alkaline. The B horizon has hue of 10YR or 7.5YR, value of 5 to 8 (4 to 6 moist), and chroma of 2 to 5. It is typically silty clay loam, but in some pedons it is silt loam. It is moderately alkaline or strongly alkaline. The Cr horizon has hue of 10YR or 7.5YR, value of 6 to 8 (5 to 7 moist), and chroma of 2 to 6.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of a soil at any given point are determined by the interaction of five factors of soil formation: climate, plants and other living organisms, parent material, relief, and time. Each of these factors influences the formation of every soil, and each modifies the effects of the other four. The relative effects of the individual factors vary from place to place. The interactions among these factors are more complex for some soils than for others.

Parent Material

Parent material is the unconsolidated material in which soils form. It either is material weathered from rocks through freezing and thawing, abrasion, erosion, or chemical processes or is material deposited by wind or water. The parent material affects texture, structure, color, natural fertility, and many other soil properties. Soils differ partly because of the various kinds of parent material. The texture of the parent material influences the rate of the downward movement of water and air and thus greatly affects soil formation. The composition of the parent material largely determines the mineralogical composition of the soil and, hence, its natural fertility. The soils in Graham County formed in alluvium, colluvium, loess, loamy outwash, and chalky limestone and shale residuum.

Alluvium is water-deposited material. Both recent and old alluvial sediments are evident in Graham County. The recent alluvium is in stream valleys. Bridgeport, Hord, Humbarger, Inavale, and Munjor soils formed in this material. Old alluvial sediments are on what are now uplands. Penden soils formed in these sediments.

Colluvium is loamy or silty material that accumulated at the base of the steeper slopes as a result of gravity. It is derived from chalky shale and limestone bedrock or from loess deposits. Armo and Eltree soils formed in colluvial material.

Loess is silty, wind-deposited material, some of which was carried hundreds of miles from its source. Peorian Loess of the Wisconsin Glaciation, which covers many of the uplands in Graham County, was deposited during the Pleistocene. In most places it is very pale brown or light gray and is calcareous and friable. Coly, Holdrege, and Uly soils formed in this material.

The bedrock that crops out in Graham County consists of chalky limestone or shale of the Upper Cretaceous System. The calcareous Nibson and Wakeen soils formed in material weathered from these chalky rocks.

Climate

Climate is an active factor of soil formation. It directly influences soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals. Soil-forming processes are most active when the soil is warm and moist.

The climate of Graham County is typical continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. Because of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons. An accumulation of lime in the lower part of the subsoil in Holdrege soils is an indication of leaching by excess moisture. The downward movement of water is a major factor in transforming parent material into a soil that has distinct horizons.

Plant and Animal Life

Plants and animals have important effects on soil formation. Plants generally influence the content of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Bacteria and fungi help to decompose the plants, thus releasing plant nutrients.

Mid and tall prairie grasses have had the greatest influence on soil formation in Graham County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. In many areas the next layer is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color.

Human activities have greatly affected soil formation. In most areas they have increased the susceptibility to erosion, increased or decreased the organic matter content, or changed the relief by land leveling and by industrial and urban development.

Relief

Relief, or lay of the land, influences the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. It is important mainly because it controls the movement of water on the surface and into the soil.

Runoff is more rapid on the steeper upland soils than on the less sloping soils. As a result, erosion is more extensive. Nibson soils formed in old parent material, but relief has restricted their formation. Runoff is medium on these moderately sloping to moderately steep soils, and much of the soil material is removed as soon as a soil forms.

Time

The length of time needed for soil formation depends largely on the other factors of soil formation. As water moves downward through the soil, soluble matter and fine particles are gradually leached from the surface layer to the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that has penetrated the surface.

Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. For example, the young Bridgeport soils, which formed in recent alluvium, show very little evidence of horizon development other than a slight darkening of the surface layer. In contrast, the older Holdrege soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and

resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:
O horizon.—An organic layer of fresh and decaying plant residue.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.
E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.
B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.
Cr horizon.—Soft, consolidated bedrock beneath the soil.
R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow

over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake in inches per hour is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate

types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-76 at Hill City, Kansas]

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.6	14.4	27.5	72	-14	0.44	0.07	0.71	1	4.7
February---	46.1	19.5	32.8	79	- 9	.59	.16	1.06	2	5.5
March------	52.3	25.5	38.9	88	- 2	1.45	.33	2.32	3	7.1
April------	65.7	38.0	51.9	92	18	1.80	.78	2.73	4	2.2
May--------	75.5	49.3	62.4	99	28	3.67	2.10	5.66	6	0.1
June-------	86.2	59.5	72.9	107	41	3.94	1.77	6.53	6	.0
July-------	91.8	65.4	78.6	107	48	3.14	1.01	4.05	5	.0
August-----	90.5	63.4	77.0	106	48	2.71	1.52	3.94	4	.0
September--	80.3	52.7	66.5	103	32	2.27	.55	4.01	4	.0
October----	70.0	40.6	55.3	94	19	1.42	.43	2.15	3	0.2
November---	53.4	26.1	39.8	78	0	.77	.03	1.74	2	3.1
December---	43.2	18.1	30.7	73	- 9	.46	.04	.73	2	4.6
Year-----	66.3	39.4	52.9	108	-17	22.66	15.82	30.03	42	27.5

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 19	Apr. 30	May 13
2 years in 10 later than--	Apr. 14	Apr. 25	May 8
5 years in 10 later than--	Apr. 5	Apr. 15	Apr. 28
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 17	Oct. 9	Sept. 29
2 years in 10 earlier than--	Oct. 21	Oct. 14	Oct. 3
5 years in 10 earlier than--	Oct. 31	Oct. 23	Oct. 13

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	187	170	147
8 years in 10	195	177	154
5 years in 10	209	191	168
2 years in 10	223	205	181
1 year in 10	230	212	188

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
An	Anselmo sandy loam, 2 to 6 percent slopes	2,110	0.4
As	Armo loam, 3 to 7 percent slopes	3,230	0.6
Br	Bridgeport silt loam	6,750	1.2
Cc	Campus-Canlon loams, 6 to 30 percent slopes	5,570	1.0
Cn	Coly silt loam, 2 to 6 percent slopes	40,100	7.0
Co	Coly silt loam, 6 to 11 percent slopes	26,100	4.5
Et	Eltree silt loam, 1 to 3 percent slopes	3,500	0.6
Hf	Holdrege silt loam, 0 to 1 percent slopes	16,600	2.9
Hg	Holdrege silt loam, 1 to 3 percent slopes	158,100	27.6
Ho	Hord silt loam	8,830	1.5
Hu	Humbarger loam, channeled	21,500	3.7
Hw	Humbarger loam, occasionally flooded	13,500	2.3
If	Inavale sand, channeled	4,480	0.8
Ih	Inavale loamy sand, hummocky	1,410	0.2
Im	Inavale loamy sand, occasionally flooded	1,420	0.2
Mu	Munjor sandy loam, occasionally flooded	9,240	1.6
Ph	Penden loam, 3 to 8 percent slopes	12,300	2.1
Pk	Penden clay loam, 3 to 8 percent slopes, eroded	12,280	2.1
Pm	Penden-Canlon loams, 7 to 20 percent slopes	18,000	3.1
Po	Penden-Uly complex, 7 to 20 percent slopes	97,500	17.0
Uc	Uly silt loam, 2 to 6 percent slopes	76,800	13.4
Ud	Uly silt loam, 6 to 11 percent slopes	10,800	1.9
Ue	Uly silt loam, 11 to 20 percent slopes	2,290	0.4
Va	Valentine loamy sand, 3 to 9 percent slopes	659	0.1
Wn	Wakeen-Nibson silt loams, 3 to 8 percent slopes	5,660	1.0
Ws	Wakeen-Nibson silt loams, 8 to 20 percent slopes	16,350	2.8
	Total	575,079	100.0

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Land capability	Winter wheat	Grain sorghum	Alfalfa hay
		Bu	Bu	Tons
An----------------------- Anselmo	IIIe	24	46	2.3
As----------------------- Armo	IIIe	29	42	---
Br----------------------- Bridgeport	IIc	35	55	3.0
Cc----------------------- Campus-Canlon	VIe	---	---	---
Cn----------------------- Coly	IIIe	22	40	---
Co----------------------- Coly	IVe	18	35	---
Et----------------------- Eltree	IIe	38	54	2.5
Hf----------------------- Holdrege	IIc	38	55	2.5
Hg----------------------- Holdrege	IIe	35	51	2.3
Ho----------------------- Hord	IIc	40	56	3.0
Hu----------------------- Humbarger	Vw	---	---	---
Hw----------------------- Humbarger	IIw	28	45	3.0
If----------------------- Inavale	VIw	---	---	---
Ih----------------------- Inavale	VIe	---	---	---
Im----------------------- Inavale	IVe	21	30	1.8
Mu----------------------- Munjor	IIIw	26	50	2.0
Ph----------------------- Penden	IIIe	26	36	---
Pk----------------------- Penden	IVe	23	33	---
Pm----------------------- Penden-Canlon	VIe	---	---	---
Po----------------------- Penden-Uly	VIe	---	---	---

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Winter wheat	Grain sorghum	Alfalfa hay
		Bu	Bu	Tons
Uc------------------------ Uly	IIIe	28	44	1.9
Ud------------------------ Uly	IVe	25	40	1.7
Ue------------------------ Uly	VIe	---	---	---
Va------------------------ Valentine	VIe	---	---	---
Wn------------------------ Wakeen-Nibson	IVe	17	27	---
Ws------------------------ Wakeen-Nibson	VIe	---	---	---

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Compo- sition
		Kind of year	Dry weight		
			Lb/acre		Pct
An: Anselmo	Sandy	Favorable	3,000	Sand bluestem	20
		Normal	2,600	Little bluestem	15
		Unfavorable	2,200	Blue grama	15
				Prairie sandreed	10
				Western wheatgrass	5
				Switchgrass	5
As: Armo	Limy Upland	Favorable	4,000	Big bluestem	35
		Normal	3,000	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
				Leadplant	5
				Western wheatgrass	5
Br: Bridgeport	Loamy Terrace	Favorable	4,000	Big bluestem	35
		Normal	3,000	Sideoats grama	25
		Unfavorable	2,000	Western wheatgrass	15
				Little bluestem	10
Cc*:					
Campus	Limy Upland	Favorable	3,000	Big bluestem	30
		Normal	2,000	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	15
				Switchgrass	5
				Blue grama	5
				Western wheatgrass	5
Canlon	Shallow Limy	Favorable	2,400	Little bluestem	35
		Normal	1,600	Sideoats grama	20
		Unfavorable	900	Big bluestem	10
				Hairy grama	5
				Blue grama	5
Cn, Co: Coly	Limy Upland	Favorable	4,000	Little bluestem	35
		Normal	3,000	Big bluestem	25
		Unfavorable	2,000	Sideoats grama	10
				Blue grama	10
				Indiangrass	5
				Switchgrass	5
Et: Eltree	Limy Upland	Favorable	4,000	Big bluestem	30
		Normal	3,000	Little bluestem	20
		Unfavorable	1,500	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
				Western wheatgrass	5
Hf, Hg: Holdrege	Loamy Upland	Favorable	4,000	Big bluestem	25
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Blue grama	10
				Western wheatgrass	10
				Indiangrass	5
Ho: Hord	Loamy Terrace	Favorable	4,500	Big bluestem	40
		Normal	3,500	Sideoats grama	15
		Unfavorable	2,500	Little bluestem	10
				Switchgrass	10
				Western wheatgrass	10
				Blue grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Hu, Hw: Humbarger	Loamy Lowland	Favorable	5,000	Big bluestem	40
		Normal	4,000	Western wheatgrass	10
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Little bluestem	5
If: Inavale	Sands	Favorable	3,500	Sand bluestem	40
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Prairie sandreed	15
				Switchgrass	5
				Blue grama	5
				Sand dropseed	5
Ih: Inavale	Sands	Favorable	3,500	Sand bluestem	40
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Prairie sandreed	15
				Switchgrass	5
				Blue grama	5
				Sand dropseed	5
Im: Inavale	Sands	Favorable	3,500	Sand bluestem	40
		Normal	3,000	Prairie sandreed	15
		Unfavorable	2,000	Little bluestem	15
				Needleandthread	15
				Switchgrass	5
				Blue grama	5
				Sand dropseed	5
Mu: Munjor	Sandy Lowland	Favorable	5,000	Sand bluestem	35
		Normal	4,000	Switchgrass	15
		Unfavorable	3,000	Indiangrass	10
				Little bluestem	10
				Western wheatgrass	5
Ph, Pk: Penden	Limy Upland	Favorable	4,000	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	10
				Switchgrass	5
				Indiangrass	5
				Western wheatgrass	5
Pm*:					
Penden	Limy Upland	Favorable	3,500	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	10
				Switchgrass	5
				Indiangrass	5
				Western wheatgrass	5
Canlon	Shallow Limy	Favorable	2,400	Little bluestem	30
		Normal	1,600	Sideoats grama	20
		Unfavorable	900	Big bluestem	10
				Switchgrass	5
				Blue grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Po*:					
Penden	Limy Upland	Favorable	4,000	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	10
				Switchgrass	5
				Indiangrass	5
				Western wheatgrass	5
Uly	Loamy Upland	Favorable	3,700	Big bluestem	30
		Normal	2,700	Little bluestem	15
		Unfavorable	2,000	Sideoats grama	15
				Blue grama	10
				Western wheatgrass	10
Uc, Ud, Ue Uly	Loamy Upland	Favorable	3,700	Big bluestem	30
		Normal	2,700	Little bluestem	15
		Unfavorable	2,000	Sideoats grama	15
				Blue grama	10
				Western wheatgrass	10
Va Valentine	Sands	Favorable	3,500	Sand bluestem	25
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Prairie sandreed	15
				Switchgrass	5
				Sand lovegrass	5
				Blue grama	5
Wn*, Ws*:					
Wakeen	Limy Upland	Favorable	3,500	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	1,000	Sideoats grama	15
				Switchgrass	5
				Blue grama	5
Nibson	Limy Upland	Favorable	3,500	Big bluestem	30
		Normal	2,500	Little bluestem	20
		Unfavorable	1,500	Sideoats grama	20
				Indiangrass	5
				Blue grama	5
				Western wheatgrass	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
An-----------------Anselmo	American plum, lilac, Amur honeysuckle, common chokecherry.	Russian mulberry, Rocky Mountain juniper.	Eastern redcedar, ponderosa pine, green ash, honeylocust, hackberry.	Siberian elm------	---
As-----------------Armo	Fragrant sumac, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, bur oak, Russian-olive, Rocky Mountain juniper.	Ponderosa pine, honeylocust, green ash, Siberian elm.	---	---
Br-----------------Bridgeport	Lilac, American plum.	Amur honeysuckle	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, hackberry, green ash, Russian-olive.	Honeylocust, Siberian elm.	Eastern cottonwood.
Cc*:					
Campus------------	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, green ash, Russian-olive, black locust.	Honeylocust, Siberian elm.	---	---
Canlon.					
Cn, Co-------------Coly	Silver buffaloberry, fragrant sumac, Siberian peashrub, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, bur oak, Russian-olive.	Green ash, ponderosa pine, honeylocust, Siberian elm.	---	---
Et-----------------Eltree	American plum-----	Amur honeysuckle, lilac.	Eastern redcedar, ponderosa pine, Russian mulberry, Russian-olive, Austrian pine, green ash.	Honeylocust, hackberry.	Eastern cottonwood.
Hf, Hg-------------Holdrege	Lilac, Amur honeysuckle, fragrant sumac.	Russian mulberry	Eastern redcedar, Austrian pine, green ash, honeylocust, hackberry, bur oak, Russian-olive.	Siberian elm------	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ho----------------- Hord	Peking cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, ponderosa pine, blue spruce, Manchurian crabapple.	Golden willow, green ash, hackberry.	Eastern cottonwood.
Hu, Hw------------ Humbarger	American plum, lilac.	Amur honeysuckle	Russian-olive, Rocky Mountain juniper, eastern redcedar, ponderosa pine, green ash, hackberry.	Honeylocust, Siberian elm.	Eastern cottonwood.
If----------------- Inavale	Lilac, American plum.	Amur honeysuckle	Russian-olive, Rocky Mountain juniper, eastern redcedar, ponderosa pine, hackberry, green ash.	Honeylocust, Siberian elm.	Eastern cottonwood.
Ih----------------- Inavale	Lilac, American plum.	Common chokecherry	Eastern redcedar, Austrian pine, Scotch pine, ponderosa pine, green ash, honeylocust, hackberry, Russian mulberry.	Siberian elm------	---
Im. Inavale					
Mu----------------- Munjor	American plum-----	Amur honeysuckle, lilac.	Eastern redcedar, ponderosa pine, green ash, Russian mulberry, Austrian pine, Russian-olive.	Honeylocust, hackberry.	Eastern cottonwood.
Ph, Pk------------ Penden	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, green ash, black locust, Russian-olive.	Honeylocust, Siberian elm.	---	---
Pm*:					
Penden-----------	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, green ash, black locust, Russian-olive.	Honeylocust, Siberian elm.	---	---
Canlon.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Po*:					
Penden	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Rocky Mountain juniper, ponderosa pine, green ash, black locust, Russian-olive.	Honeylocust, Siberian elm.	---	---
Uly	Amur honeysuckle, lilac.	Common chokecherry, Russian mulberry.	Eastern redcedar, green ash, Russian-olive, honeylocust, Austrian pine, hackberry, bur oak.	Siberian elm	---
Uc, Ud Uly	Amur honeysuckle, lilac.	Common chokecherry, Russian mulberry.	Eastern redcedar, green ash, Russian-olive, honeylocust, Austrian pine, hackberry, bur oak.	Siberian elm	---
Ue Uly	Amur honeysuckle, lilac.	Common chokecherry, Russian mulberry.	Eastern redcedar, green ash, Russian-olive, honeylocust, Austrian pine, hackberry, bur oak.	Siberian elm	---
Va Valentine	---	Eastern redcedar, Rocky Mountain juniper.	Ponderosa pine, Austrian pine, jack pine.	---	---
Wn*, Ws*:					
Wakeen	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, Rocky Mountain juniper, bur oak.	Honeylocust, Siberian elm, ponderosa pine, green ash.	---	---
Nibson.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
An: Anselmo	Slight	Slight	Moderate: slope.	Slight.
As: Armo	Slight	Slight	Moderate: slope.	Slight.
Br: Bridgeport	Severe: flooding.	Slight	Slight	Slight.
Cc*:				
Campus	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Canlon	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock, small stones.	Moderate: slope.
Cn: Coly	Slight	Slight	Moderate: slope.	Slight.
Co: Coly	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
Et: Eltree	Slight	Slight	Moderate: slope.	Slight.
Hf: Holdrege	Slight	Slight	Slight	Slight.
Hg: Holdrege	Slight	Slight	Moderate: slope.	Slight.
Ho: Hord	Severe: flooding.	Slight	Slight	Slight.
Hu: Humbarger	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Hw: Humbarger	Severe: flooding.	Slight	Moderate: flooding.	Slight.
If: Inavale	Severe: flooding, too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
Ih: Inavale	Severe: flooding.	Slight	Severe: slope.	Slight.
Im: Inavale	Severe: flooding.	Slight	Slight	Slight.
Mu: Munjor	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Ph, Pk: Penden	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Pm*:				
Penden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Canlon	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock, small stones.	Slight.
Po*:				
Penden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Uly	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Uc Uly	Slight	Slight	Moderate: slope.	Slight.
Ud Uly	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Ue Uly	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.
Va Valentine	Slight	Slight	Severe: slope.	Slight.
Wn*:				
Wakeen	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Nibson	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight.
Ws*:				
Wakeen	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Nibson	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
An------------ Anselmo	Fair	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
As------------ Armo	Fair	Good	Good	Fair	Poor	Very poor	Good	Very poor	Fair.
Br------------ Bridgeport	Good	Good	Good	Fair	Poor	Poor	Good	Poor	Fair.
Cc*:									
Campus----------	Poor	Fair	Good	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Canlon----------	Very poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Cn, Co---------- Coly	Fair	Good	Good	Fair	Poor	Very poor	Fair	Very poor	Fair.
Et------------ Eltree	Good	Good	Fair	Fair	Poor	Very poor	Good	Very poor	Fair.
Hf, Hg---------- Holdrege	Good	Good	Fair	Fair	Very poor	Very poor	Good	Very poor	Fair.
Ho------------ Hord	Good	Good	Good	Good	Very poor	Very poor	Good	Very poor	Good.
Hu------------ Humbarger	Fair	Fair	Good	Fair	Poor	Poor	Fair	Poor	Fair.
Hw------------ Humbarger	Fair	Good	Fair	Poor	Poor	Poor	Fair	Poor	Poor.
If------------ Inavale	Very poor	Poor	Fair	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Ih------------ Inavale	Poor	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Im------------ Inavale	Fair	Fair	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Mu------------ Munjor	Fair	Fair	Good	Good	Poor	Poor	Fair	Poor	Good.
Ph, Pk---------- Penden	Fair	Good	Fair	Poor	Very poor	Poor	Fair	Very poor	Fair.
Pm*:									
Penden----------	Poor	Fair	Fair	Poor	Very poor	Poor	Fair	Very poor	Fair.
Canlon----------	Poor	Poor	Poor	Poor	Very poor	Very poor	Poor	Very poor	Poor.
Po*:									
Penden----------	Poor	Fair	Fair	Poor	Very poor	Poor	Fair	Very poor	Fair.
Uly------------	Poor	Fair	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Wetland wildlife	Rangeland wildlife
Uc, Ud------------- Uly	Fair	Good	Good	Fair	Very poor	Very poor	Fair	Very poor	Good.
Ue----------------- Uly	Poor	Fair	Good	Fair	Very poor	Very poor	Poor	Very poor	Fair.
Va----------------- Valentine	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Wn*:									
Wakeen------------	Fair	Good	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Nibson------------	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.
Ws*:									
Wakeen------------	Poor	Fair	Fair	Poor	Very poor	Very poor	Fair	Very poor	Fair.
Nibson------------	Poor	Fair	Fair	Fair	Very poor	Very poor	Fair	Very poor	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
An----------------- Anselmo	Severe: cutbanks cave.	Slight-----------	Slight-----------	Moderate: slope.	Moderate: frost action.
As----------------- Armo	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Severe: low strength.
Br----------------- Bridgeport	Slight-----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Cc*:					
Campus-----------	Severe: depth to rock.	Moderate: slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, low strength, slope.
Canlon-----------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.
Cn----------------- Coly	Slight-----------	Slight-----------	Slight-----------	Moderate: slope.	Moderate: frost action.
Co----------------- Coly	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.
Et----------------- Eltree	Slight-----------	Slight-----------	Slight-----------	Slight------------	Moderate: low strength, frost action.
Hf, Hg------------ Holdrege	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Ho----------------- Hord	Slight-----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Hu, Hw------------ Humbarger	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
If----------------- Inavale	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Ih----------------- Inavale	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
Im----------------- Inavale	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Mu----------------- Munjor	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Ph, Pk------------ Penden	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Pm*:					
Penden	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Canlon	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Po*:					
Penden	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.
Uly	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.
Uc Uly	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.
Ud Uly	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.
Ue Uly	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.
Va Valentine	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
Wn*:					
Wakeen	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Nibson	Severe: depth to rock.	Moderate: shrink-swell, depth to rock.	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: low strength.
Ws*:					
Wakeen	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Nibson	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
An: Anselmo	Slight	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
As: Armo	Slight	Moderate: seepage, slope.	Slight	Slight	Fair: too clayey, thin layer.
Br: Bridgeport	Moderate: flooding.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Cc*:					
Campus	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Canlon	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, slope.
Cn: Coly	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Co: Coly	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Et: Eltree	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Hf: Holdrege	Slight	Moderate: seepage.	Slight	Slight	Good.
Hg: Holdrege	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ho: Hord	Moderate: flooding.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
Hu, Hw: Humbarger	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
If: Inavale	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: seepage, too sandy, flooding.	Severe: seepage, flooding.	Poor: too sandy, seepage.
Ih: Inavale	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Im: Inavale	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: seepage, too sandy, flooding.	Severe: seepage, flooding.	Poor: too sandy, seepage.
Mu: Munjor	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: thin layer.
Ph, Pk: Penden	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Pm*:					
Penden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Canlon	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Po*:					
Penden	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Uly	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Uc: Uly	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ud: Uly	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ue: Uly	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Va: Valentine	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Wn*:					
Wakeen	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Nibson	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Ws*:					
Wakeen	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Nibson	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
An----- Anselmo	Good-----	Probable-----	Improbable: too sandy.	Fair: thin layer.
As----- Armo	Good-----	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Br----- Bridgeport	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cc*:				
Campus-----	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, small stones.
Canlon-----	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones, slope.
Cn----- Coly	Good-----	Improbable: excess fines.	Improbable: excess fines.	Good.
Co----- Coly	Good-----	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Et----- Eltree	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Hf, Hg----- Holdrege	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ho----- Hord	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Hu, Hw----- Humbarger	Good-----	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
If, Ih, Im----- Inavale	Good-----	Probable-----	Improbable: too sandy.	Poor: too sandy.
Mu----- Munjor	Good-----	Probable-----	Improbable: too sandy.	Good.
Ph----- Penden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Pk----- Penden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Pm*:				
Penden-----	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Pm*:				
Canlon	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.
Po*:				
Penden	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Uly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Uc: Uly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ud: Uly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Ue: Uly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Va: Valentine	Good	Probable	Improbable: too sandy.	Poor: area reclaim.
Wn*:				
Wakeen	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock.
Nibson	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.
Ws*:				
Wakeen	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, slope.
Nibson	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "moderate" and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
An-----------------Anselmo	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope-----------	Too sandy, soil blowing.	Favorable.
As-----------------Armo	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope-----------	Favorable-------	Favorable.
Br-----------------Bridgeport	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable-------	Erodes easily	Erodes easily.
Cc*:						
Campus------------	Severe: slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Canlon------------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Cn-----------------Coly	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
Co-----------------Coly	Severe: slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Et-----------------Eltree	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable-------	Erodes easily	Erodes easily.
Hf, Hg-------------Holdrege	Moderate: seepage.	Severe: piping.	Deep to water	Favorable-------	Erodes easily	Erodes easily.
Ho-----------------Hord	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable-------	Favorable-------	Favorable.
Hu, Hw-------------Humbarger	Moderate: seepage.	Severe: piping.	Deep to water	Flooding--------	Favorable-------	Favorable.
If, Ih, Im---------Inavale	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Mu-----------------Munjor	Severe: seepage.	Severe: piping.	Deep to water	Flooding--------	Soil blowing----	Favorable.
Ph, Pk-------------Penden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope-----------	Erodes easily	Erodes easily.
Pm*:						
Penden------------	Severe: slope.	Moderate: piping.	Deep to water	Slope-----------	Slope, erodes easily.	Slope, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Pm*:						
Canlon	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Po*:						
Penden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Uly	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Uc Uly	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Ud, Ue Uly	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Va Valentine	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Wn*:						
Wakeen	Moderate: seepage, depth to rock, slope.	Moderate: thin layer, piping.	Deep to water	Depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Nibson	Severe: depth to rock.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Ws*:						
Wakeen	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Nibson	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
An-- Anselmo	0-10	Sandy loam	SM, ML, SM-SC, CL-ML	A-4, A-2	0	100	100	60-100	30-65	<25	NP-7
	10-26	Fine sandy loam, loam.	SM, ML, SM-SC, CL-ML	A-4	0	100	100	90-100	35-65	<25	NP-7
	26-60	Loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-4, A-2	0	100	100	65-100	12-45	<25	NP-7
As-- Armo	0-15	Loam	CL	A-6, A-4	0	95-100	90-100	90-100	70-95	25-40	7-18
	15-46	Silty clay loam, clay loam, loam.	CL	A-6, A-4, A-7	0	95-100	85-100	70-100	65-80	25-45	7-22
	46-60	Silt loam, clay loam.	CL, SC, GC	A-6, A-4	0	60-85	50-85	50-60	40-55	25-35	8-18
Br-- Bridgeport	0-18	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	65-90	20-35	4-19
	18-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6	0	100	100	90-100	65-100	25-40	8-20
Cc*: Campus	0-15	Loam	CL, CL-ML, ML	A-4, A-6	0	100	95-100	80-100	55-90	20-40	3-20
	15-24	Loam, clay loam	CL, ML	A-6, A-7, A-4	0	100	100	75-95	50-80	33-45	8-20
	24-30	Loam, clay loam	CL, ML, SC, SM	A-6, A-7, A-4	0	90-100	70-100	65-85	40-80	33-45	8-20
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Canlon	0-6	Loam	CL, CL-ML	A-4, A-6	0	90-100	75-100	65-100	50-90	20-40	4-20
	6-12	Loam, gravelly loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	75-100	55-100	50-95	35-85	20-40	4-20
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cn, Co-- Coly	0-6	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	85-100	85-100	20-40	2-15
	6-60	Silt loam, very fine sandy loam, loam.	ML, CL, CL-ML	A-4	0	100	100	85-100	85-100	20-35	2-10
Et-- Eltree	0-9	Silt loam	CL, ML, CL-ML	A-4, A-6	0	100	100	85-100	65-100	20-40	3-15
	9-25	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6	0	100	95-100	85-100	85-100	25-40	5-20
	25-60	Silt loam, loam, silty clay loam.	CL	A-4, A-6, A-7-6	0	100	95-100	90-100	65-100	25-45	7-22
Hf, Hg-- Holdrege	0-6	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	20-40	2-18
	6-22	Silty clay loam	CL	A-7, A-6	0	100	100	98-100	90-100	30-50	15-35
	22-60	Silt loam, silty clay loam.	CL	A-6, A-4	0	100	100	95-100	95-100	25-40	9-17

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Ho----------------- Hord	0-13	Silt loam--------	CL, ML, CL-ML	A-4, A-6	0	100	100	95-100	85-100	20-35	3-18
	13-34	Silt loam, silty clay loam, loam.	CL	A-6, A-4	0	100	100	98-100	85-100	25-40	8-23
	34-60	Silt loam, very fine sandy loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	100	85-100	25-40	6-21
Hu, Hw------------ Humbarger	0-21	Loam-------------	CL, CL-ML	A-6, A-4	0	95-100	90-100	90-100	65-90	20-35	4-15
	21-31	Clay loam, loam, silty clay loam.	CL	A-6, A-4	0	95-100	90-100	80-95	55-85	25-40	8-20
	31-60	Clay loam, sandy loam, loam.	CL, CL-ML, SC, SM-SC	A-6, A-4	0	95-100	90-100	80-95	40-80	20-40	5-20
If---------------- Inavale	0-6	Sand-------------	SM, SP-SM, SM-SC	A-2, A-3	0	100	90-100	65-85	5-30	<25	NP-5
	6-60	Sand, loamy fine sand, loamy sand.	SP-SM, SM, SM-SC	A-2, A-3	0	100	100	70-90	5-30	<25	NP-5
Ih, Im------------ Inavale	0-6	Loamy sand-------	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	85-95	5-35	<25	NP-5
	6-60	Sand, loamy fine sand, loamy sand.	SP-SM, SM, SM-SC	A-2, A-3	0	100	100	70-90	5-30	<25	NP-5
Mu---------------- Munjor	0-6	Sandy loam-------	SM, ML, CL-ML, SM-SC	A-2-4, A-4	0	100	95-100	65-100	25-55	15-30	NP-7
	6-25	Fine sandy loam, loamy sand, sandy loam.	SM, SC, ML, CL	A-4	0	100	95-100	65-100	35-65	15-30	3-10
	25-60	Loamy sand, sand, sandy loam.	SM, SP-SM	A-2-4, A-3	0	95-100	95-100	55-100	5-30	---	NP
Ph---------------- Penden	0-7	Loam-------------	CL	A-4, A-6	0	100	100	85-100	65-95	25-40	7-20
	7-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	60-90	30-45	11-25
	27-60	Clay loam, loam	CL	A-6, A-7-6	0	100	100	75-100	55-75	30-45	11-25
Pk---------------- Penden	0-7	Clay loam--------	CL	A-6, A-7-6	0	100	100	85-100	65-95	30-45	11-25
	7-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	60-90	30-45	11-25
	27-60	Clay loam, loam	CL	A-6, A-7-6	0	100	100	75-100	55-75	30-45	11-25
Pm*:											
Penden----------	0-7	Loam-------------	CL	A-4, A-6	0	100	100	85-100	65-95	25-40	7-20
	7-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	60-90	30-45	11-25
	27-60	Clay loam, loam	CL	A-6, A-7-6	0	100	100	75-100	55-75	30-45	11-25
Canlon----------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0	90-100	75-100	65-100	50-90	20-40	4-20
	6-12	Loam, gravelly loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	75-100	55-100	50-95	35-85	20-40	4-20
	12	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Po*:											
Penden----------	0-7	Loam-------------	CL	A-4, A-6	0	100	100	85-100	65-95	25-40	7-20
	7-27	Clay loam, loam, silty clay loam.	CL	A-6, A-7-6	0	100	100	85-100	60-90	30-45	11-25
	27-60	Clay loam, loam	CL	A-6, A-7-6	0	100	100	75-100	55-75	30-45	11-25
Uly-------------	0-12	Silt loam--------	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	2-15
	12-28	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	3-15
	28-60	Silt loam, very fine sandy loam.	CL, ML	A-4, A-6	0	100	100	100	95-100	25-40	3-15
Uc, Ud, Ue------- Uly	0-12	Silt loam--------	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	2-15
	12-28	Silt loam, silty clay loam.	ML, CL	A-4, A-6	0	100	100	100	95-100	25-40	3-15
	28-60	Silt loam, very fine sandy loam.	CL, ML	A-4, A-6	0	100	100	100	95-100	25-40	3-15
Va--------------- Valentine	0-9	Loamy sand-------	SM, SP-SM, SP	A-2, A-3	0	100	100	95-100	2-35	---	NP
	9-60	Fine sand, loamy fine sand, loamy sand.	SM, SP-SM, SP	A-2, A-3	0	100	100	90-100	2-20	---	NP
Wn*, Ws*:											
Wakeen----------	0-12	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	75-95	25-40	7-20
	12-33	Silty clay loam, silt loam.	CL, ML	A-6, A-7-6	0	95-100	85-100	75-100	60-95	30-50	10-25
	33	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Nibson----------	0-6	Silt loam--------	CL	A-4, A-6	0-15	85-100	80-95	65-95	60-90	25-40	8-20
	6-14	Silty clay loam, silt loam.	CL	A-6, A-7	0-15	85-95	80-95	60-90	55-90	30-45	10-25
	14	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
									K	T		
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
An----------------	0-10	10-18	1.30-1.60	0.6-6.0	0.13-0.18	5.6-7.8	<2	Low--------	0.20	5	3	1-2
Anselmo	10-26	10-18	1.40-1.60	2.0-6.0	0.15-0.19	5.6-7.8	<2	Low--------	0.20			
	26-60	5-18	1.50-1.70	2.0-6.0	0.08-0.16	5.6-7.8	<2	Low--------	0.20			
As----------------	0-15	18-27	1.25-1.40	0.6-2.0	0.21-0.24	6.6-8.4	<2	Low--------	0.28	5	4L	1-3
Armo	15-46	18-35	1.30-1.45	0.6-2.0	0.15-0.21	7.9-8.4	<2	Low--------	0.28			
	46-60	18-30	1.30-1.50	0.6-2.0	0.15-0.21	7.9-8.4	<2	Low--------	0.28			
Br----------------	0-18	14-27	1.30-1.40	0.6-2.0	0.20-0.24	6.6-8.4	<2	Low--------	0.32	5	6	1-4
Bridgeport	18-60	18-30	1.35-1.50	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43			
Cc*:												
Campus-----------	0-15	15-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	4	4L	1-2
	15-24	18-35	1.30-1.40	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	24-30	18-35	1.40-1.60	0.6-2.0	0.15-0.19	7.9-8.4	<2	Low--------	0.28			
	30	---	---	---	---	---	---	-----------	----			
Canlon-----------	0-6	12-27	1.30-1.45	0.6-2.0	0.15-0.24	7.4-8.4	<2	Low--------	0.32	2	4L	---
	6-12	8-27	1.35-1.50	0.6-2.0	0.15-0.22	7.4-8.4	<2	Low--------	0.32			
	12	---	---	---	---	---	---	-----------	----			
Cn, Co------------	0-6	18-24	1.30-1.50	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.43	5	4L	1-2
Coly	6-60	18-24	1.30-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43			
Et----------------	0-9	12-27	1.25-1.35	0.6-2.0	0.20-0.24	6.6-8.4	<2	Low--------	0.32	5	6	1-3
Eltree	9-25	18-27	1.30-1.45	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43			
	25-60	18-35	1.35-1.45	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low--------	0.43			
Hf, Hg------------	0-6	15-25	1.40-1.60	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	1-3
Holdrege	6-22	28-35	1.20-1.40	0.6-2.0	0.18-0.20	6.6-7.8	<2	Moderate	0.43			
	22-60	18-30	1.30-1.50	0.6-2.0	0.17-0.20	6.6-8.4	<2	Moderate	0.43			
Ho----------------	0-13	17-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
Hord	13-34	20-35	1.35-1.45	0.6-2.0	0.17-0.22	6.1-7.8	<2	Low--------	0.32			
	34-60	18-30	1.30-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Low--------	0.43			
Hu, Hw------------	0-21	14-27	1.30-1.40	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.28	5	4L	1-3
Humbarger	21-31	16-35	1.40-1.50	0.6-2.0	0.18-0.20	7.9-8.4	<2	Moderate	0.28			
	31-60	12-32	1.40-1.50	0.6-2.0	0.13-0.20	7.9-8.4	<2	Low--------	0.28			
If----------------	0-6	1-5	1.50-1.60	6.0-20	0.07-0.09	6.1-7.8	<2	Low--------	0.15	5	1	.5-1
Inavale	6-60	3-10	1.50-1.60	6.0-20	0.05-0.10	6.6-8.4	<2	Low--------	0.17			
Ih, Im------------	0-6	7-18	1.50-1.60	6.0-20	0.10-0.12	6.1-7.8	<2	Low--------	0.17	5	2	.5-1
Inavale	6-60	3-10	1.50-1.60	6.0-20	0.05-0.10	6.6-8.4	<2	Low--------	0.17			
Mu----------------	0-6	7-15	1.30-1.40	2.0-6.0	0.14-0.20	7.4-8.4	<2	Low--------	0.24	5	3	.5-1
Munjor	6-25	7-15	1.30-1.40	2.0-6.0	0.13-0.18	7.4-8.4	<2	Low--------	0.24			
	25-60	1-5	1.40-1.50	6.0-20	0.06-0.09	7.4-8.4	<2	Low--------	0.24			
Ph----------------	0-7	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-4
Penden	7-27	24-35	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.37			
	27-60	24-35	1.30-1.50	0.6-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.37			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Pk----------------- Penden	0-7	28-35	1.30-1.45	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.28	5	4L	1-4
	7-27	24-35	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.37			
	27-60	24-35	1.30-1.50	0.6-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.37			
Pm*:												
Penden-----------	0-7	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-4
	7-27	24-35	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.37			
	27-60	24-35	1.30-1.50	0.6-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.37			
Canlon-----------	0-6	12-27	1.30-1.45	0.6-2.0	0.15-0.24	7.4-8.4	<2	Low--------	0.32	2	4L	---
	6-12	8-27	1.35-1.50	0.6-2.0	0.15-0.22	7.4-8.4	<2	Low--------	0.32			
	12	---	---	---	---	---	---	-----------	----			
Po*:												
Penden-----------	0-7	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-4
	7-27	24-35	1.35-1.50	0.6-2.0	0.15-0.19	7.9-8.4	<2	Moderate	0.37			
	27-60	24-35	1.30-1.50	0.6-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.37			
Uly--------------	0-12	17-27	1.20-1.30	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.32	5	6	1-3
	12-28	20-30	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
	28-60	18-27	1.10-1.20	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
Uc, Ud, Ue-------- Uly	0-12	17-27	1.20-1.30	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low--------	0.32	5	6	1-3
	12-28	20-30	1.20-1.30	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
	28-60	18-27	1.10-1.20	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
Va----------------- Valentine	0-9	2-10	1.70-1.90	6.0-20	0.10-0.12	5.6-7.3	<2	Low--------	0.17	5	2	.5-1
	9-60	0-8	1.70-1.90	6.0-20	0.05-0.11	5.6-7.3	<2	Low--------	0.15			
Wn*, Ws*:												
Wakeen-----------	0-12	18-27	1.30-1.45	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.32	4	4L	1-3
	12-33	18-35	1.35-1.50	0.6-2.0	0.18-0.22	7.4-9.0	<2	Moderate	0.43			
	33	---	---	---	---	---	---	-----------	----			
Nibson-----------	0-6	15-27	1.25-1.35	0.6-2.0	0.20-0.24	7.4-9.0	<2	Low--------	0.32	2	4L	---
	6-14	18-35	1.30-1.40	0.6-2.0	0.18-0.22	7.9-9.0	<2	Moderate	0.32			
	14	---	---	---	---	---	---	-----------	----			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare" and "very brief" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Hard-ness	Uncoated steel	Concrete
					In			
An----------------- Anselmo	B	None---------	---	---	>60	---	Moderate	Low.
As----------------- Armo	B	None---------	---	---	>60	---	Low-------	Low.
Br----------------- Bridgeport	B	Rare---------	---	---	>60	---	Low-------	Low.
Cc*:								
Campus------------	B	None---------	---	---	20-40	Hard	Low-------	Low.
Canlon------------	D	None---------	---	---	10-20	Hard	Low-------	Low.
Cn, Co------------- Coly	B	None---------	---	---	>60	---	High------	Low.
Et----------------- Eltree	B	None---------	---	---	>60	---	Low-------	Low.
Hf, Hg------------- Holdrege	B	None---------	---	---	>60	---	Low-------	Low.
Ho----------------- Hord	B	Rare---------	---	---	>60	---	High------	Low.
Hu----------------- Humbarger	B	Frequent-----	Very brief	Apr-Sep	>60	---	Low-------	Low.
Hw----------------- Humbarger	B	Occasional	Very brief	Apr-Sep	>60	---	Low-------	Low.
If----------------- Inavale	A	Frequent-----	Very brief	Jan-Jul	>60	---	Moderate	Low.
Ih----------------- Inavale	A	Rare---------	---	---	>60	---	Moderate	Low.
Im----------------- Inavale	A	Occasional	Very brief	Jan-Jul	>60	---	Moderate	Low.
Mu----------------- Munjor	B	Occasional	Very brief	Apr-Sep	>60	---	Moderate	Low.
Ph, Pk------------- Penden	B	None---------	---	---	>60	---	Moderate	Low.
Pm*:								
Penden------------	B	None---------	---	---	>60	---	Moderate	Low.
Canlon------------	D	None---------	---	---	10-20	Hard	Low-------	Low.
Po*:								
Penden------------	B	None---------	---	---	>60	---	Moderate	Low.
Uly---------------	B	None---------	---	---	>60	---	High------	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Hard-ness	Uncoated steel	Concrete
					In			
Uc, Ud, Ue-------- Uly	B	None--------	---	---	>60	---	High-----	Low.
Va---------------- Valentine	A	None--------	---	---	>60	---	Low------	Low.
Wn*, Ws*:								
Wakeen-----------	B	None--------	---	---	20-40	Soft	Moderate	Low.
Nibson-----------	D	None--------	---	---	10-20	Soft	Low------	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

[LL means liquid limit; PI, plasticity index; MD, maximum dry density; and OM, optimum moisture]

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							LL	PI	Moisture density	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm			MD	OM
										Pct		Lb/ft3	Pct
Coly silt loam: (S83KS-065-001)													
Ap----- 0 to 6	A-6	CL	100	100	100	95	46	14	5	37	14	97	23
AC, C-- 6 to 60	A-6	CL	100	100	100	95	48	14	3	37	12	97	21
Humbarger loam: (S83KS-065-002)													
A------ 0 to 21	A-6	CL	100	100	98	80	33	9	2	39	14	95	22
AC----- 21 to 31	A-6	CL	100	100	98	66	30	11	5	30	11	107	16
C------ 31 to 60	A-6	CL	100	100	100	83	37	17	9	36	15	101	18
Humbarger silt loam: (S83KS-065-003)													
Ap----- 0 to 21	A-6	CL	100	100	95	83	48	13	5	36	15	100	19
AC----- 21 to 31	A-6	CL	100	100	83	64	29	7	2	33	13	109	14
C------ 31 to 60	A-6	CL	100	100	94	80	34	9	4	33	12	107	16

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Anselmo	Coarse-loamy, mixed, mesic Typic Haplustolls
Armo	Fine-loamy, mixed, mesic Entic Haplustolls
Bridgeport	Fine-silty, mixed, mesic Fluventic Haplustolls
Campus	Fine-loamy, mixed, mesic Typic Calciustolls
Canlon	Loamy, mixed (calcareous), mesic Lithic Ustorthents
Coly	Fine-silty, mixed (calcareous), mesic Typic Ustorthents
Eltree	Fine-silty, mixed, mesic Pachic Haplustolls
Holdrege	Fine-silty, mixed, mesic Typic Argiustolls
Hord	Fine-silty, mixed, mesic Cumulic Haplustolls
Humbarger	Fine-loamy, mixed, mesic Cumulic Haplustolls
Inavale	Sandy, mixed, mesic Typic Ustifluvents
Munjor	Coarse-loamy, mixed (calcareous), mesic Typic Ustifluvents
*Nibson	Loamy, carbonatic, mesic, shallow Entic Haplustolls
Penden	Fine-loamy, mixed, mesic Typic Calciustolls
Uly	Fine-silty, mixed, mesic Typic Haplustolls
Valentine	Mixed, mesic Typic Ustipsamments
Wakeen	Fine-silty, carbonatic, mesic Entic Haplustolls

Interpretive Groups

INTERPRETIVE GROUPS

Map symbol	Map unit	Land capability*	Prime farmland*	Range site
An	Anselmo sandy loam, 2 to 6 percent	IIIe	Yes	Sandy.
As	Armo loam, 3 to 7 percent slopes	IIIe	Yes	Limy Upland.
Br	Bridgeport silt loam	IIc	Yes	Loamy Terrace.
Cc	Campus-Canlon loams, 6 to 30 percent slopes	VIe	No	
	Campus			Limy Upland.
	Canlon			Shallow Limy.
Cn	Coly silt loam, 2 to 6 percent slopes	IIIe	Yes	Limy Upland.
Co	Coly silt loam, 6 to 11 percent slopes	IVe	No	Limy Upland.
Et	Eltree silt loam, 1 to 3 percent slopes	IIe	Yes	Limy Upland.
Hf	Holdrege silt loam, 0 to 1 percent slopes	IIc	Yes	Loamy Upland.
Hg	Holdrege silt loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Ho	Hord silt loam	IIc	Yes	Loamy Terrace.
Hu	Humbarger loam, channeled	Vw	No	Loamy Lowland.
Hw	Humbarger loam, occasionally flooded	IIw	Yes	Loamy Lowland.
If	Inavale sand, channeled	VIw	No	Sands.
Ih	Inavale loamy sand, hummocky	VIe	No	Sands.
Im	Inavale loamy sand, occasionally flooded	IVe	No	Sands.
Mu	Munjor sandy loam, occasionally flooded	IIIw	Yes	Sandy Lowland.
Ph	Penden loam, 3 to 8 percent slopes	IIIe	Yes	Limy Upland.
Pk	Penden clay loam, 3 to 8 percent slopes, eroded	IVe	No	Limy Upland.
Pm	Penden-Canlon loams, 7 to 20 percent slopes	VIe	No	
	Penden			Limy Upland.
	Canlon			Shallow Limy.
Po	Penden-Uly complex, 7 to 20 percent slopes	VIe	No	
	Penden			Limy Upland.
	Uly			Loamy Upland.
Uc	Uly silt loam, 2 to 6 percent slopes	IIIe	Yes	Loamy Upland.
Ud	Uly silt loam, 6 to 11 percent slopes	IVe	No	Loamy Upland.
Ue	Uly silt loam, 11 to 20 percent slopes	VIe	No	Loamy Upland.
Va	Valentine loamy sand, 3 to 9 percent slopes	VIe	No	Sands.
Wn	Wakeen-Nibson silt loams, 3 to 8 percent slopes	IVe	No	
	Wakeen			Limy Upland.
	Nibson			Limy Upland.
Ws	Wakeen-Nibson silt loams, 8 to 20 percent slopes	VIe	No	
	Wakeen			Limy Upland.
	Nibson			Limy Upland.

* A soil complex is treated as a single management unit in the land capability and prime farmland columns.

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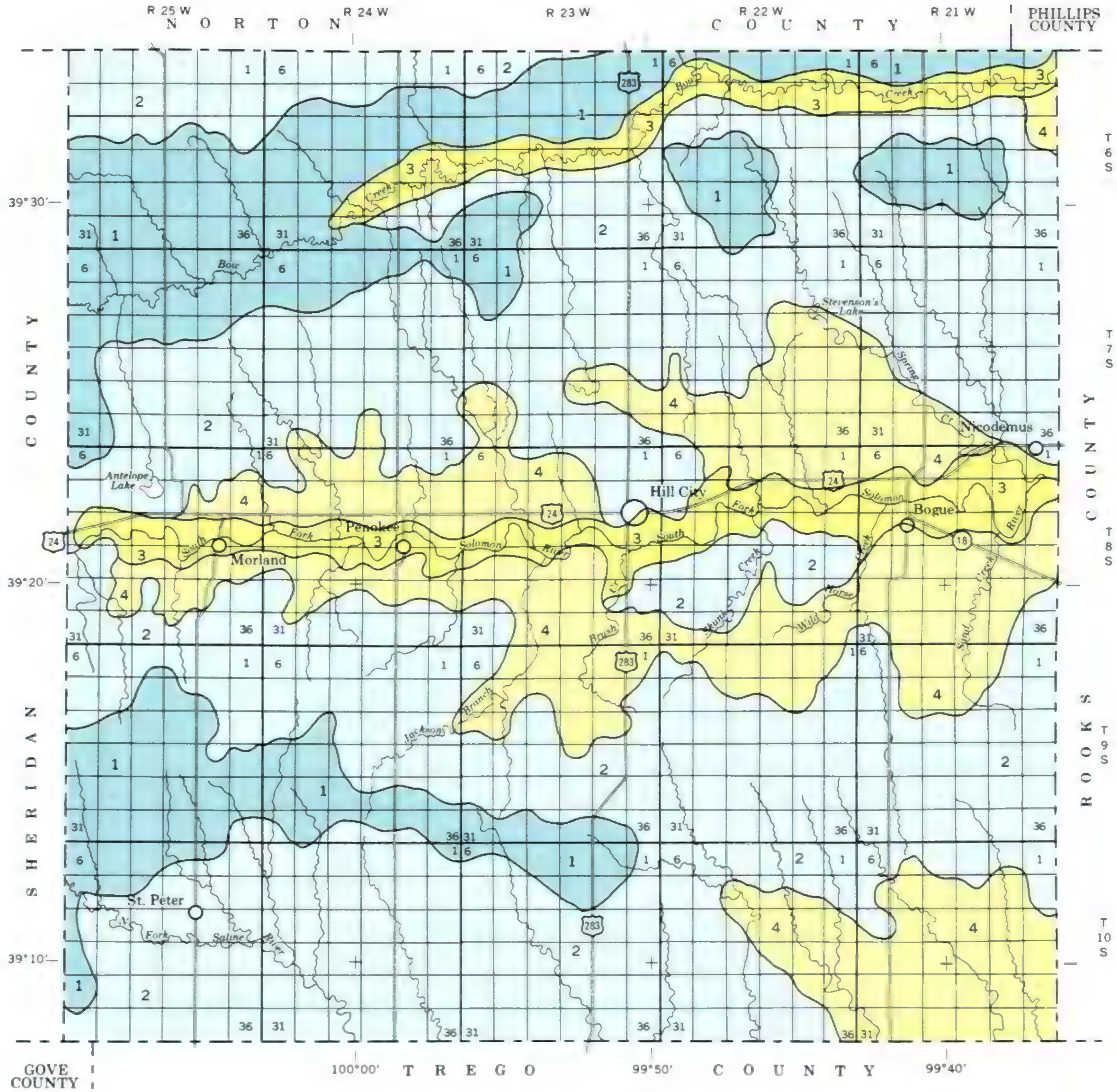


LEGEND

1	HOLDREGE-ULY-COLY association: Deep, nearly level to moderately steep, well drained soils that have a silty subsoil; on uplands
2	HOLDREGE-ULY-PENDEN association: Deep, nearly level to moderately steep, well drained soils that have a silty or loamy subsoil; on uplands
3	HORD-BRIDGEPORT-MUNJOR association: Deep, nearly level, well drained soils that have a silty or loamy and sandy subsoil; on stream terraces and flood plains
4	ULY-PENDEN-WAKEEN association: Deep and moderately deep, moderately sloping to moderately steep, well drained soils that have a silty or loamy subsoil; on uplands

Compiled 1985

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

N

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

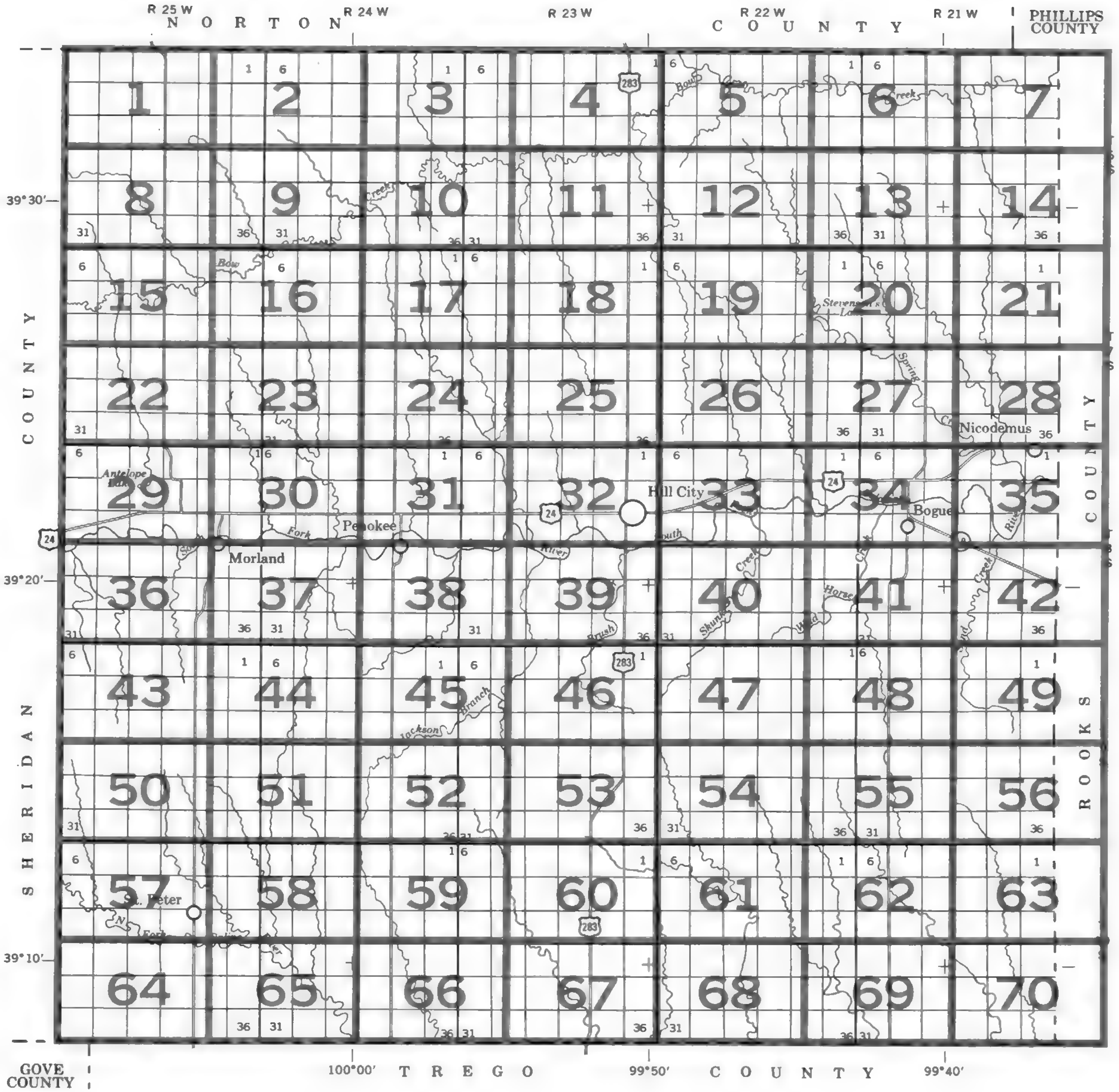
GENERAL SOIL MAP
GRAHAM COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



N

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

INDEX TO MAP SHEETS
GRAHAM COUNTY, KANSAS

Scale 1:253,440

1 0 1 2 3 4 Miles

1 0 4 8 Km

SOIL LEGEND

SYMBOL	NAME
An	Anselmo sandy loam, 2 to 6 percent slopes
As	Armo loam, 3 to 7 percent slopes
Br	Bridgeport silt loam
Cc	Campus-Canlon loams, 6 to 30 percent slopes
Cn	Coly silt loam, 2 to 6 percent slopes
Co	Coly silt loam, 6 to 11 percent slopes
Et	Eltree silt loam, 1 to 3 percent slopes
Hf	Holdrege silt loam, 0 to 1 percent slopes
Hg	Holdrege silt loam, 1 to 3 percent slopes
Ho	Hord silt loam
Hu	Humbarger loam, channeled
Hw	Humbarger loam, occasionally flooded
If	Inavale sand, channeled
Ih	Inavale loamy sand, hummocky
Im	Inavale loamy sand, occasionally flooded
Mu	Munjor sandy loam, occasionally flooded
Ph	Penden loam, 3 to 8 percent slopes
Pk	Penden clay loam, 3 to 8 percent slopes, eroded
Pm	Penden-Canlon loams, 7 to 20 percent slopes
Po	Penden-Uly complex, 7 to 20 percent slopes
Uc	Uly silt loam, 2 to 6 percent slopes
Ud	Uly silt loam, 6 to 11 percent slopes
Ue	Uly silt loam, 11 to 20 percent slopes
Va	Valentine loamy sand, 3 to 9 percent slopes
Wn	Wakeen-Nibson silt loams, 3 to 8 percent slopes
Ws	Wakeen-Nibson silt loams, 8 to 20 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate
- Federal
- State
- County, farm or ranch

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label)
- Located object (label)
- Tank (label)
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label)
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial
- Intermittent

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Shallow soil spot up to 3 acres in size

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 1

GRAHAM COUNTY, KANSAS NO. 1

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 2

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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GRAHAM COUNTY, KANSAS NO. 2

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 3

GRAHAM COUNTY, KANSAS NO. 3

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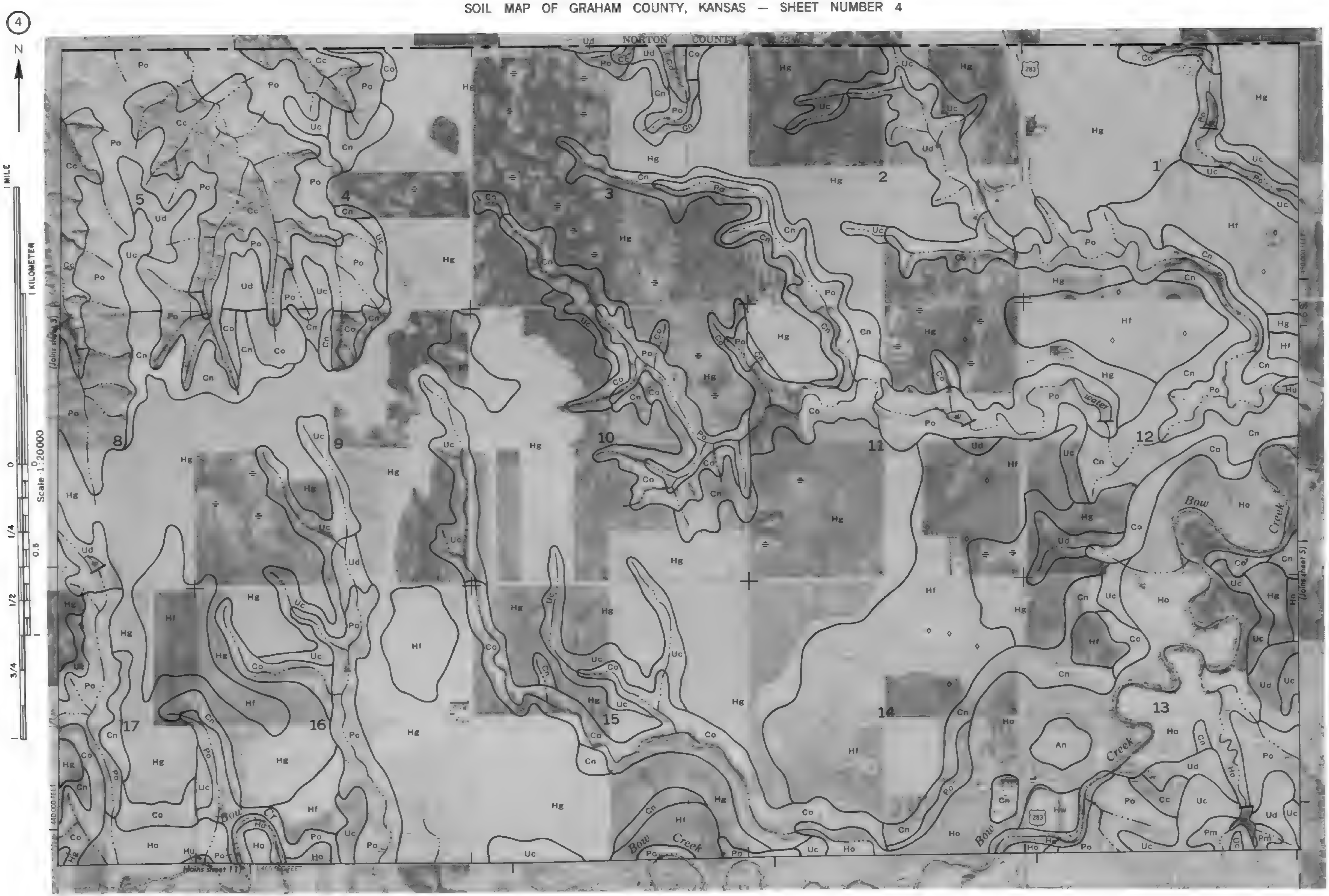
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 4



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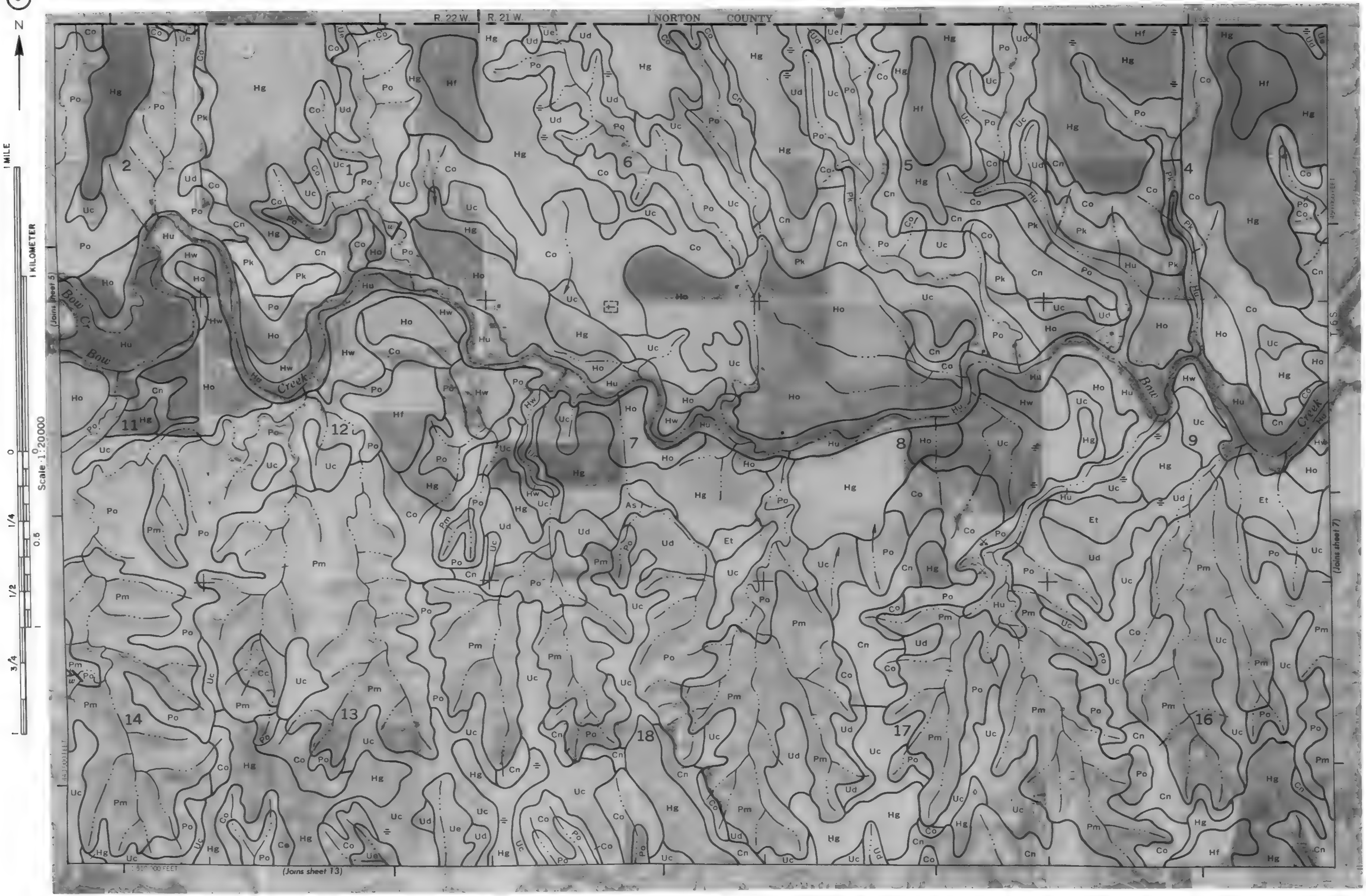
GRAHAM COUNTY, KANSAS NO. 4

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 5

GRAHAM COUNTY, KANSAS NO. 5

6

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 6



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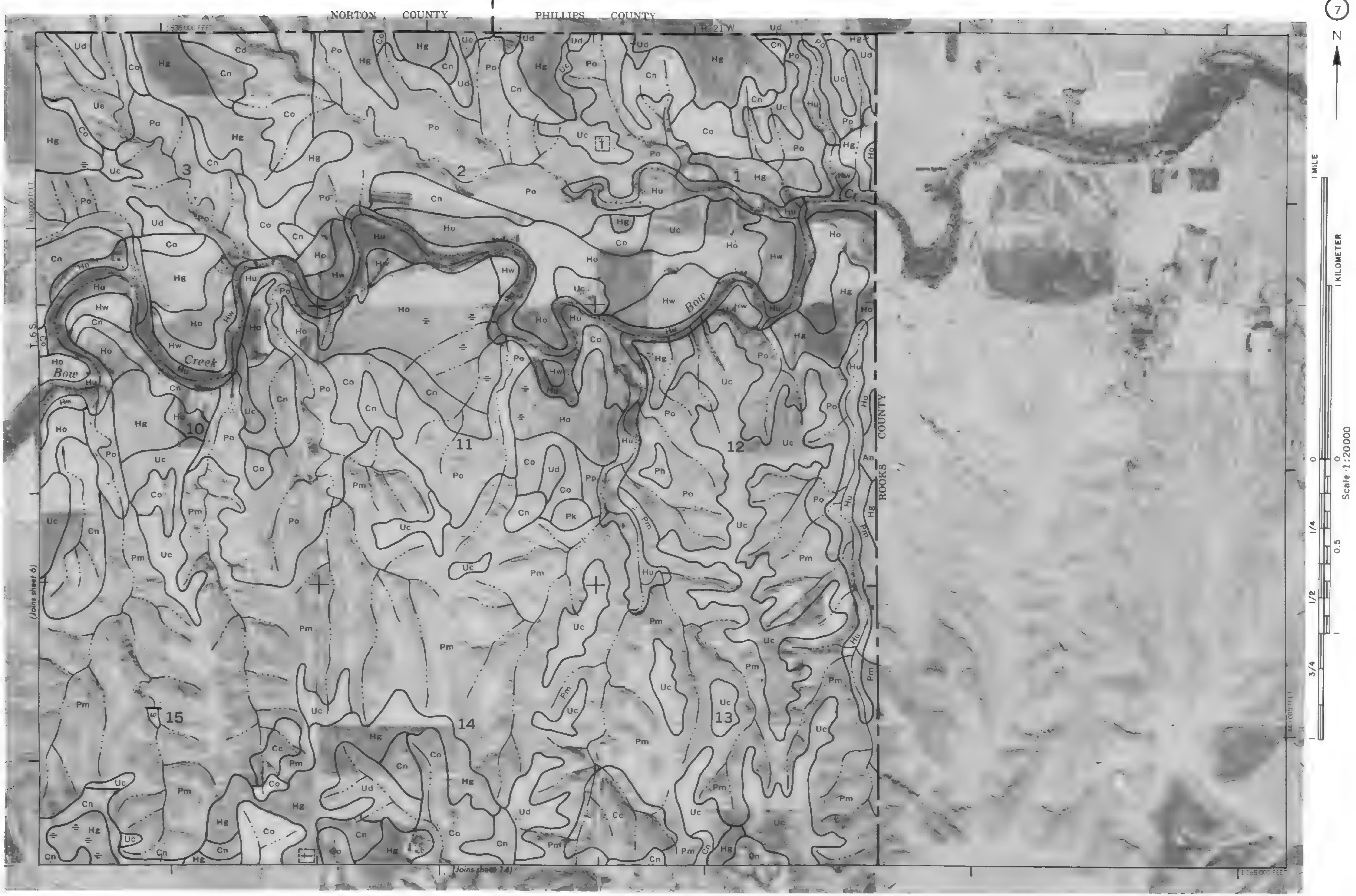
GRAHAM COUNTY, KANSAS NO. 6

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 7



GRAHAM COUNTY, KANSAS NO. 7

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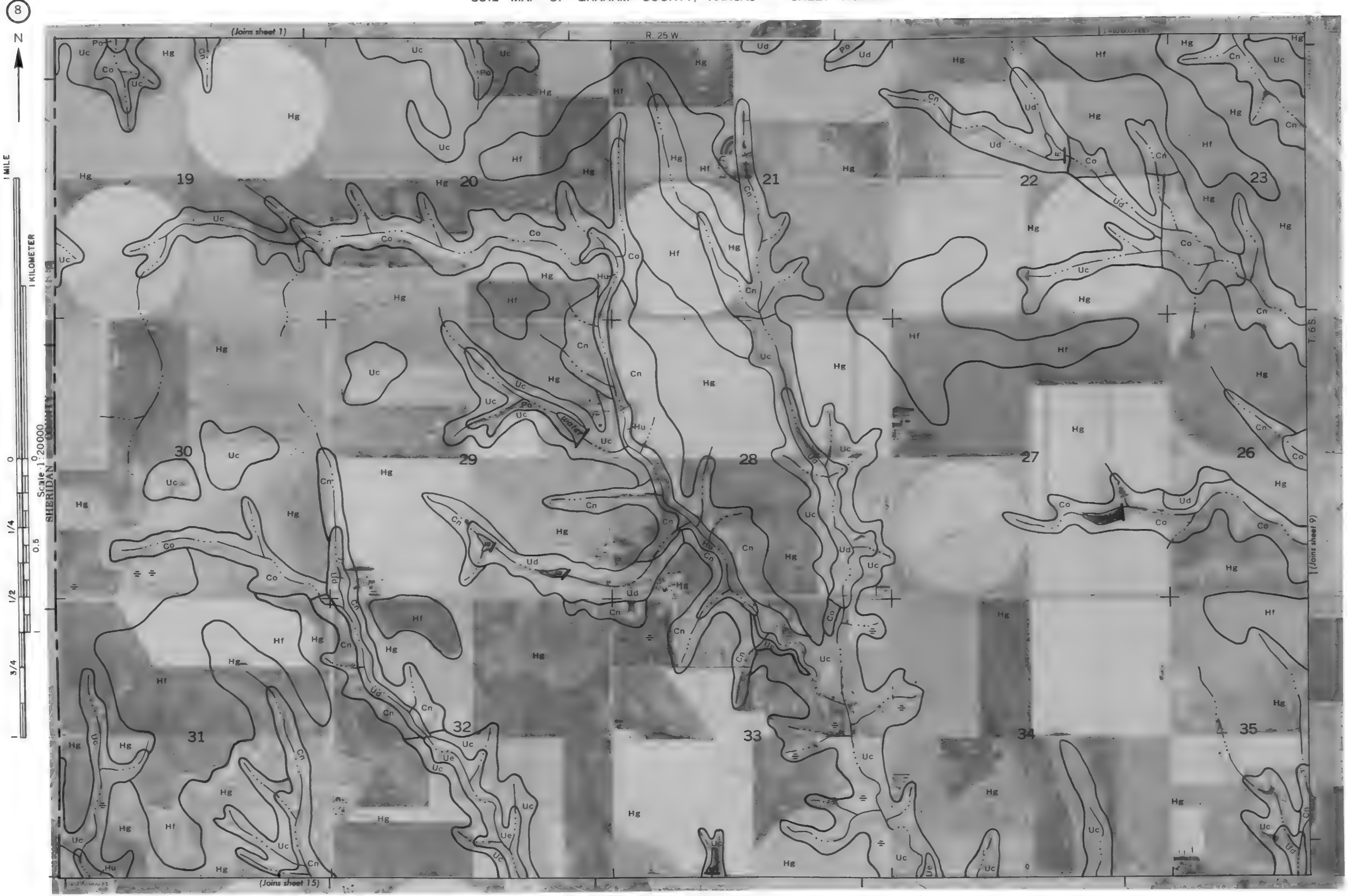
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 8



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Coordinate grid ticks and land division corners, if shown, are approximately positioned

GRAHAM COUNTY, KANSAS NO. 8

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 9

GRAHAM COUNTY, KANSAS NO. 9

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(10)

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 10

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 11

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12

N

1 MILE

1 KILOMETER

Scale 1:20000

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 12

GRAHAM COUNTY, KANSAS NO. 13

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SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 14

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GRAHAM COUNTY, KANSAS NO. 14

GRAHAM COUNTY, KANSAS NO. 15

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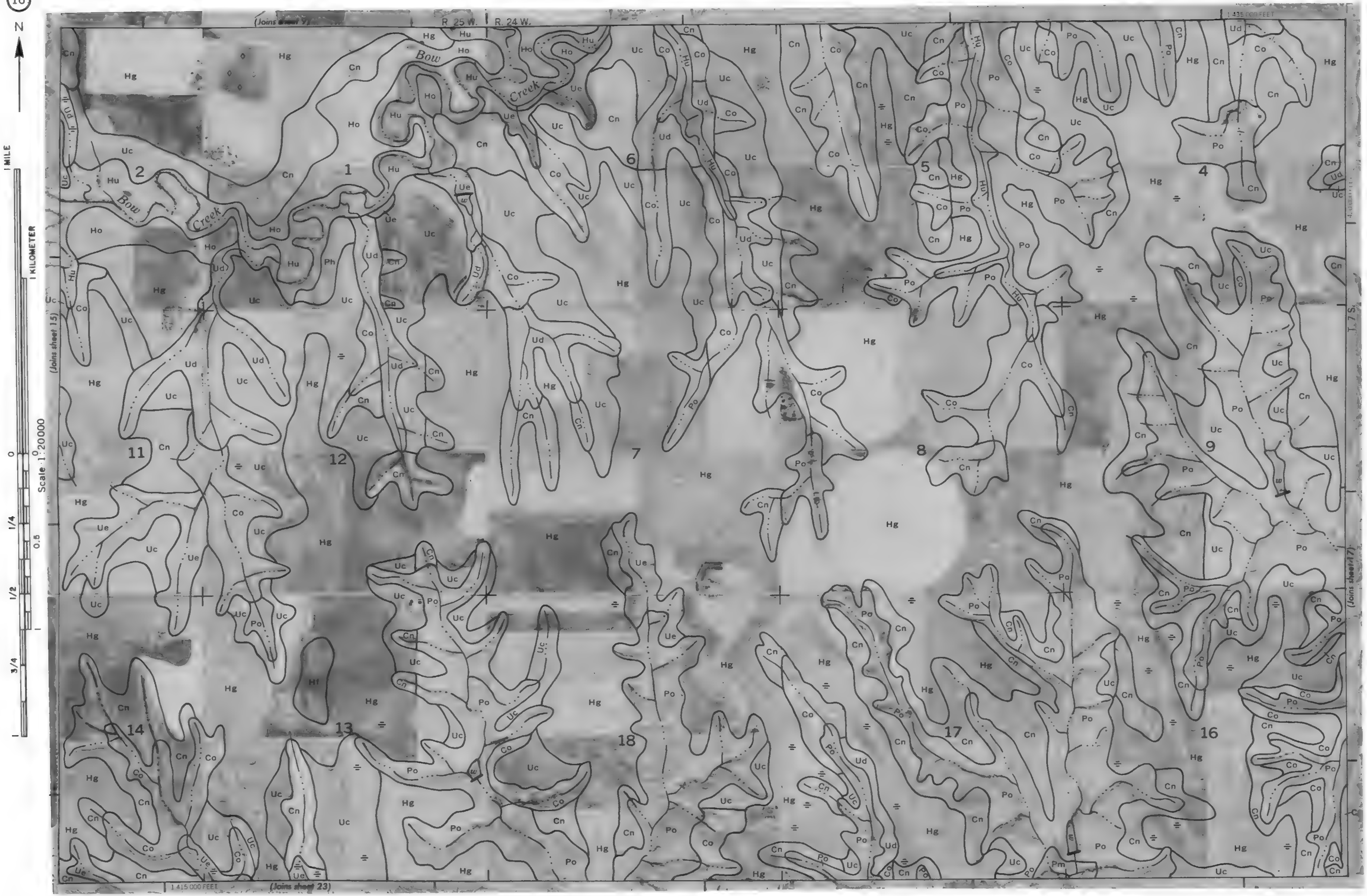
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 16

16



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GRAHAM COUNTY, KANSAS NO. 16

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 17

GRAHAM COUNTY, KANSAS NO. 17

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 18

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 20

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 20

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 21

21

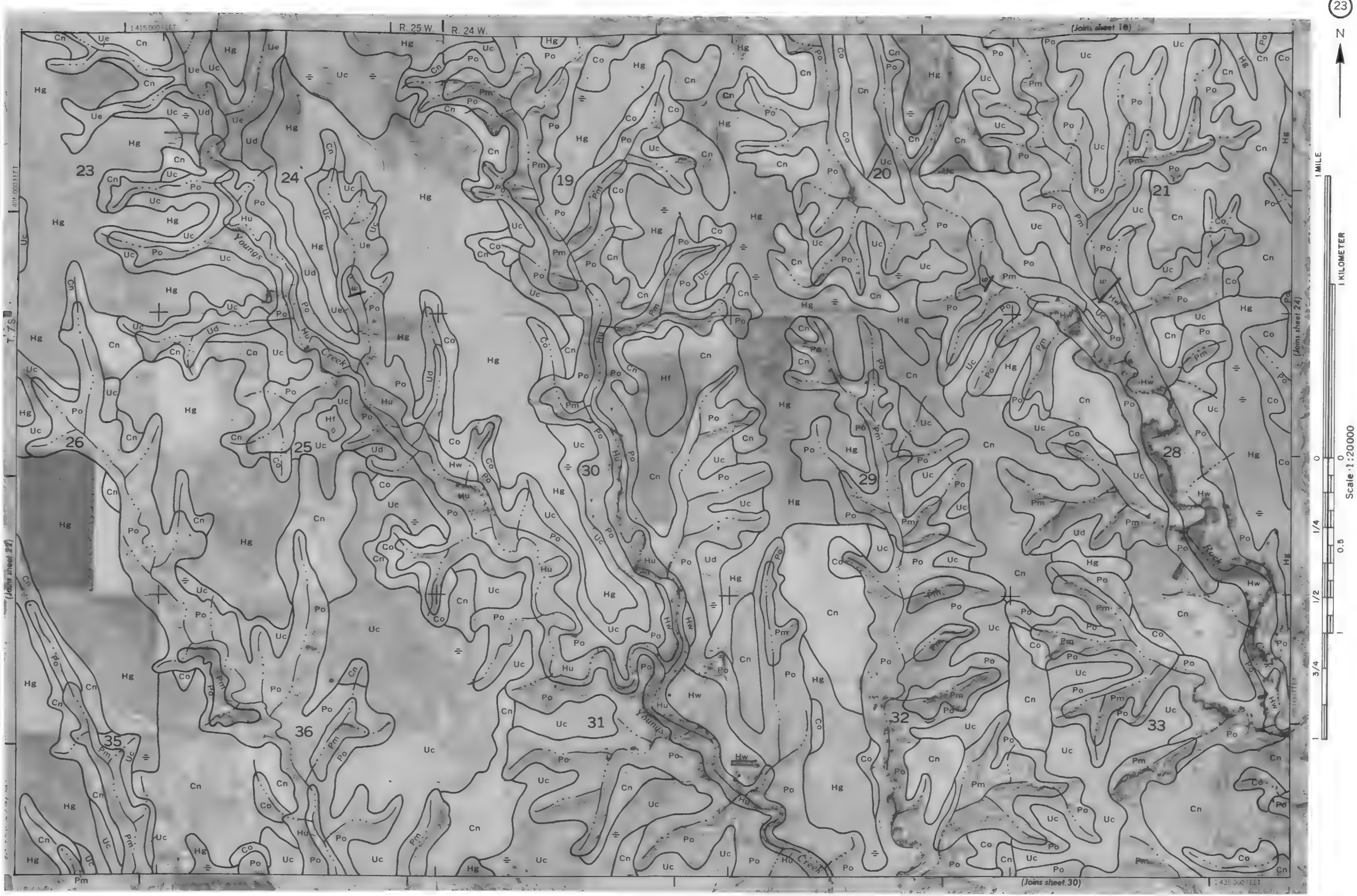
GRAHAM COUNTY, KANSAS NO. 21

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 23

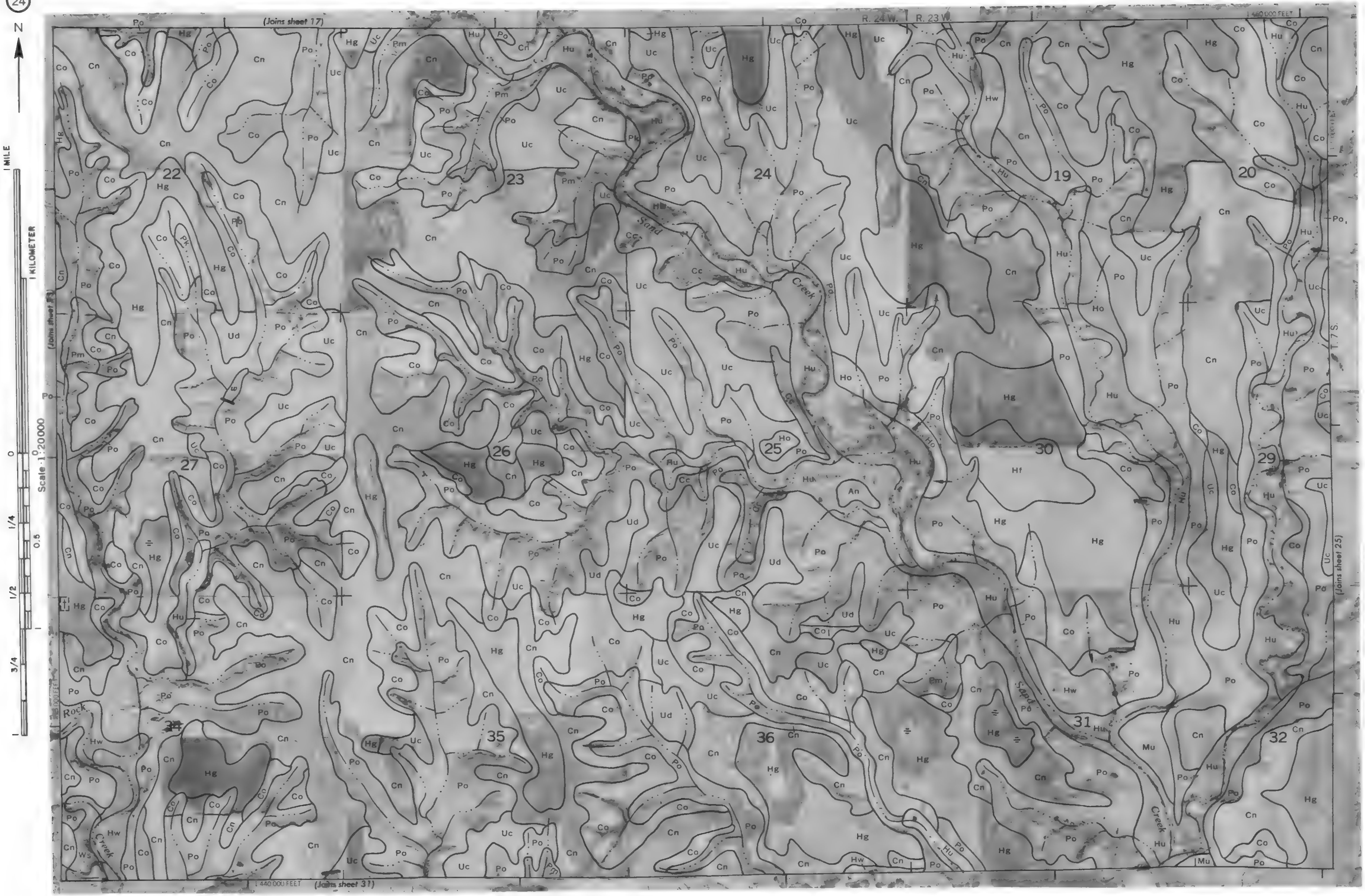
23



GRAHAM COUNTY, KANSAS NO. 23

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 24

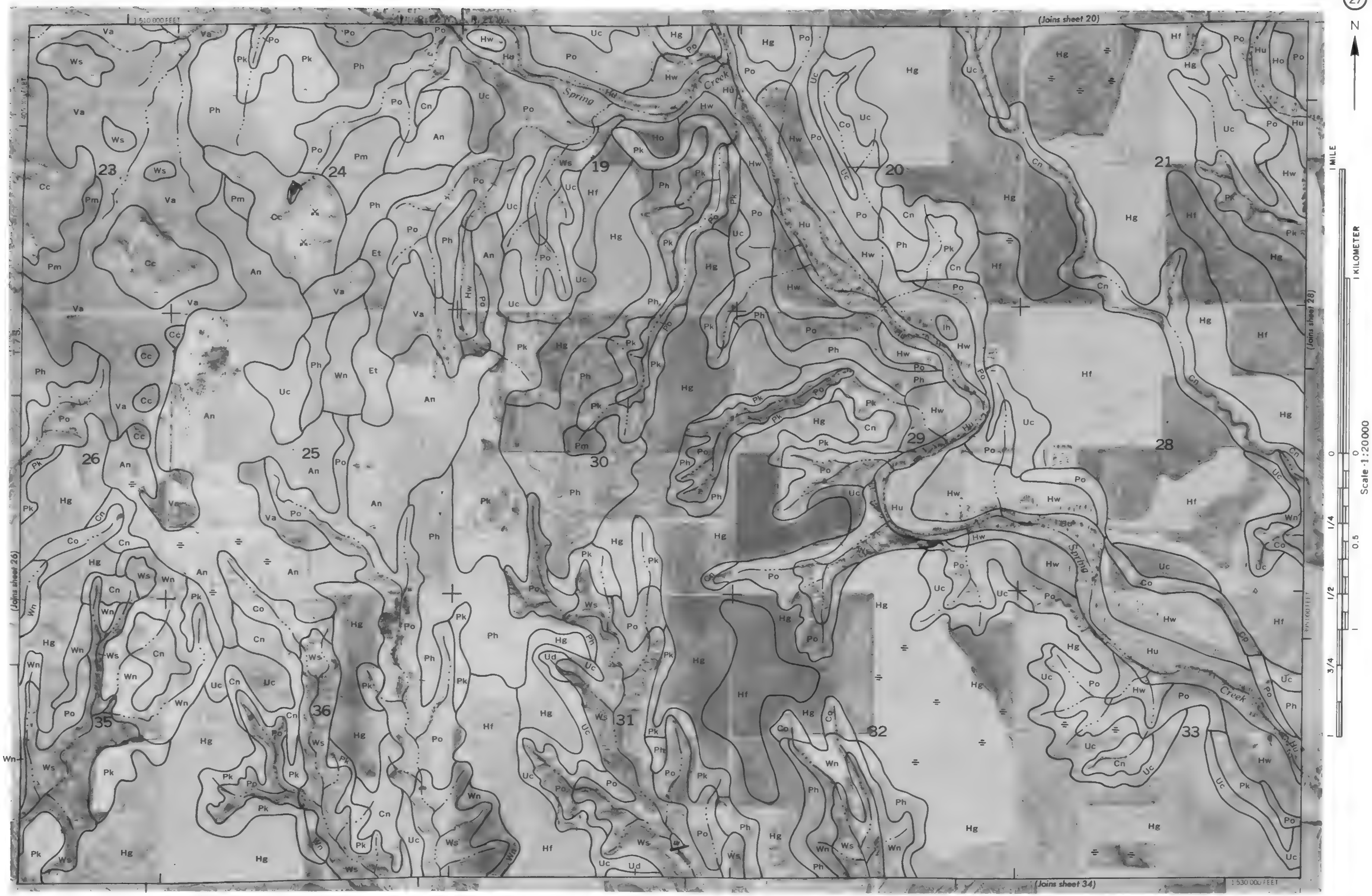


This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 25

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

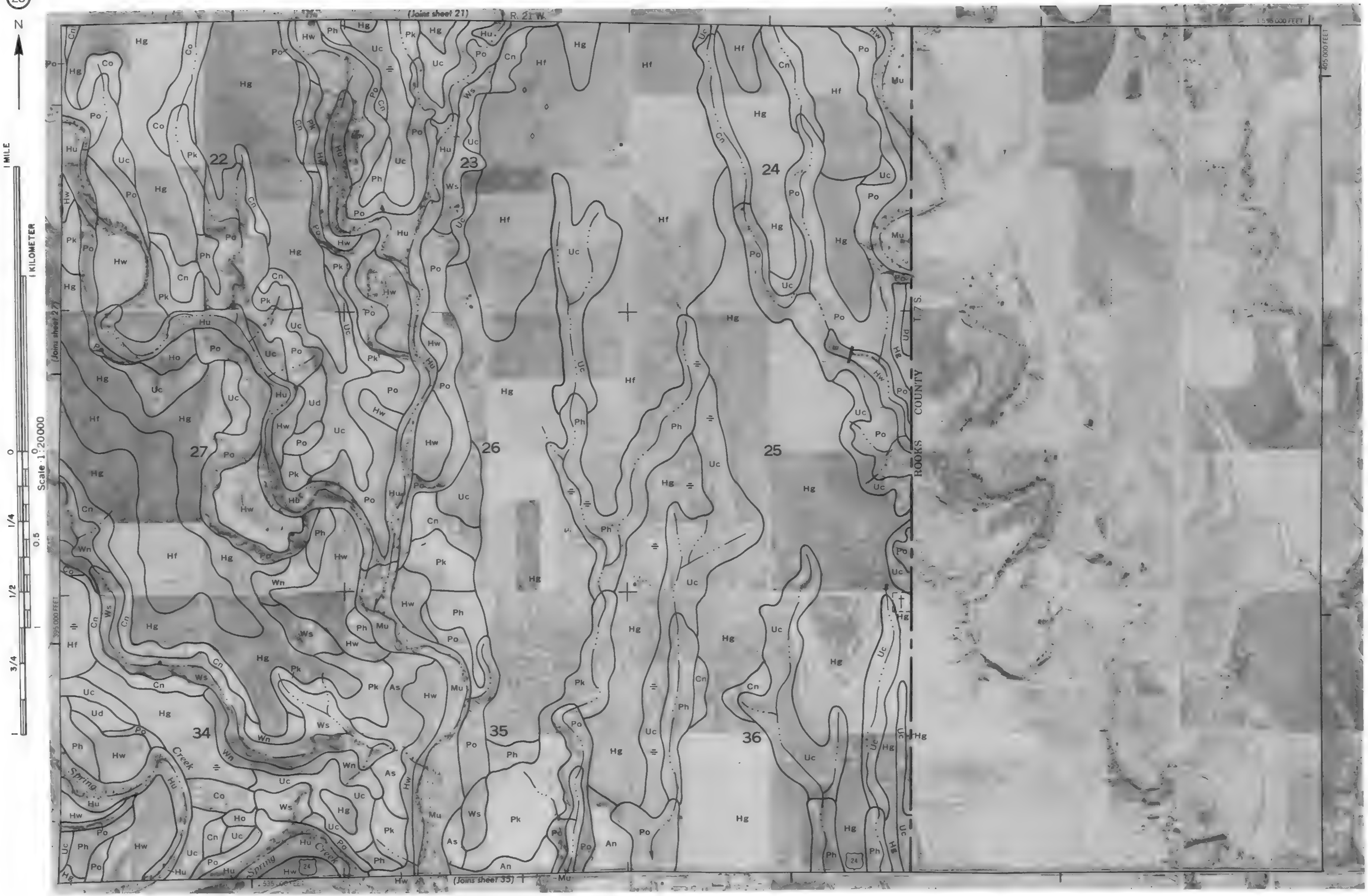
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



GRAHAM COUNTY, KANSAS NO. 27

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

(28)



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

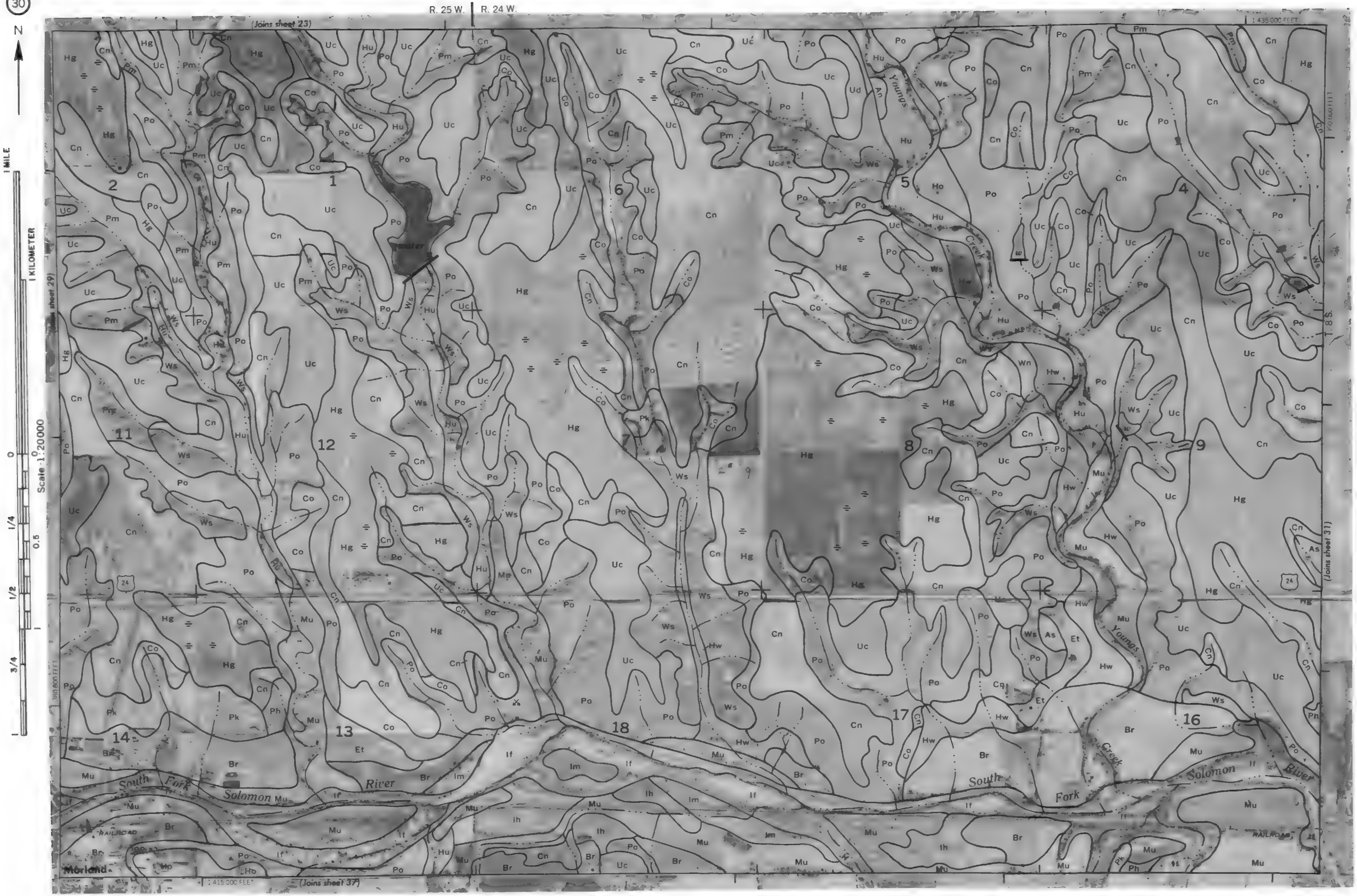
GRAHAM COUNTY, KANSAS NO. 28

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 29

GRAHAM COUNTY, KANSAS NO. 29

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

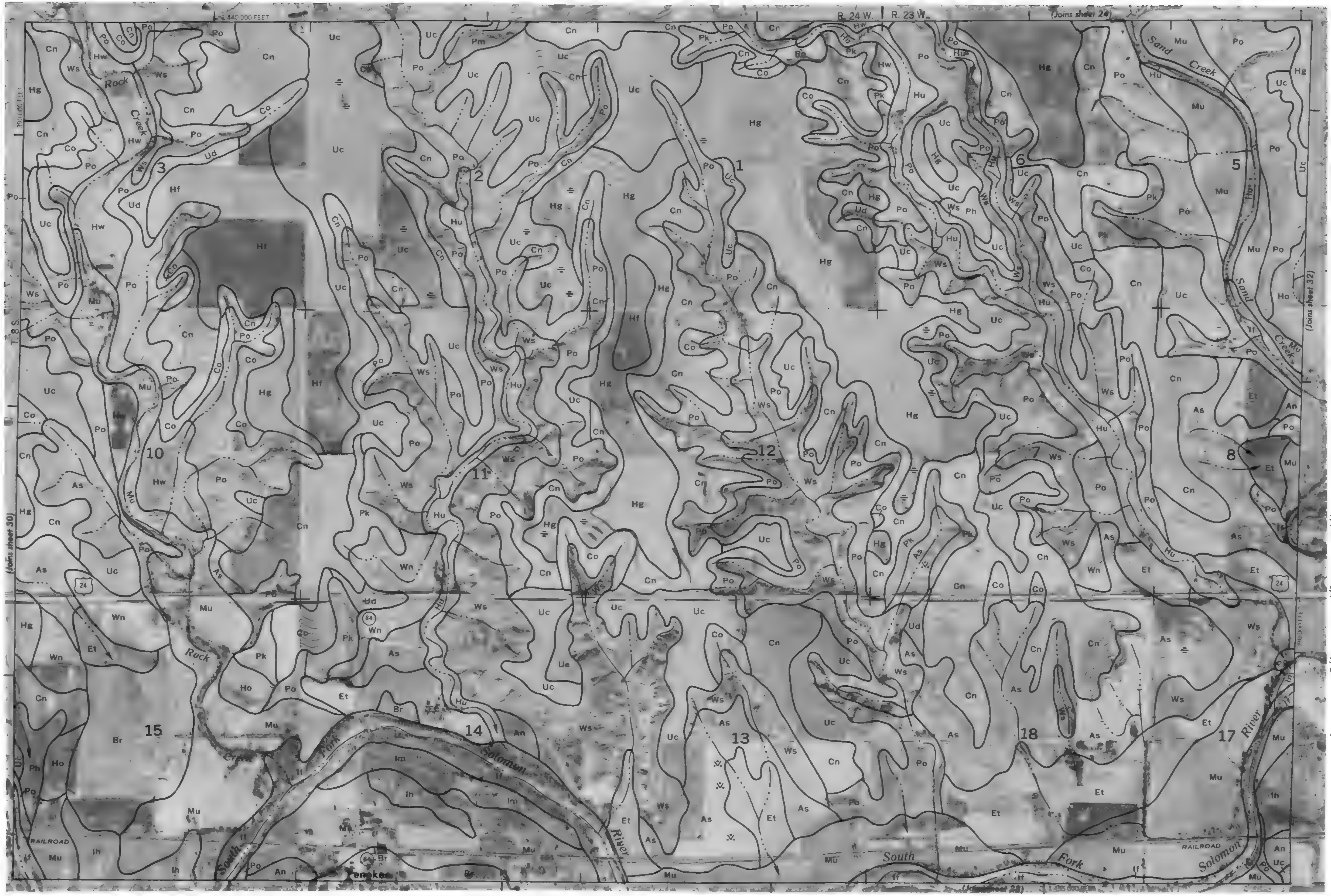
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 30



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

GRAHAM COUNTY, KANSAS NO. 30

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 31



(31)

N

1 MILE

1 KILOMETER

Scale 1:20000

GRAHAM COUNTY, KANSAS NO. 31

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 32

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 32

GRAHAM COUNTY, KANSAS NO. 33

This soil survey map is compiled on 1979 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

34

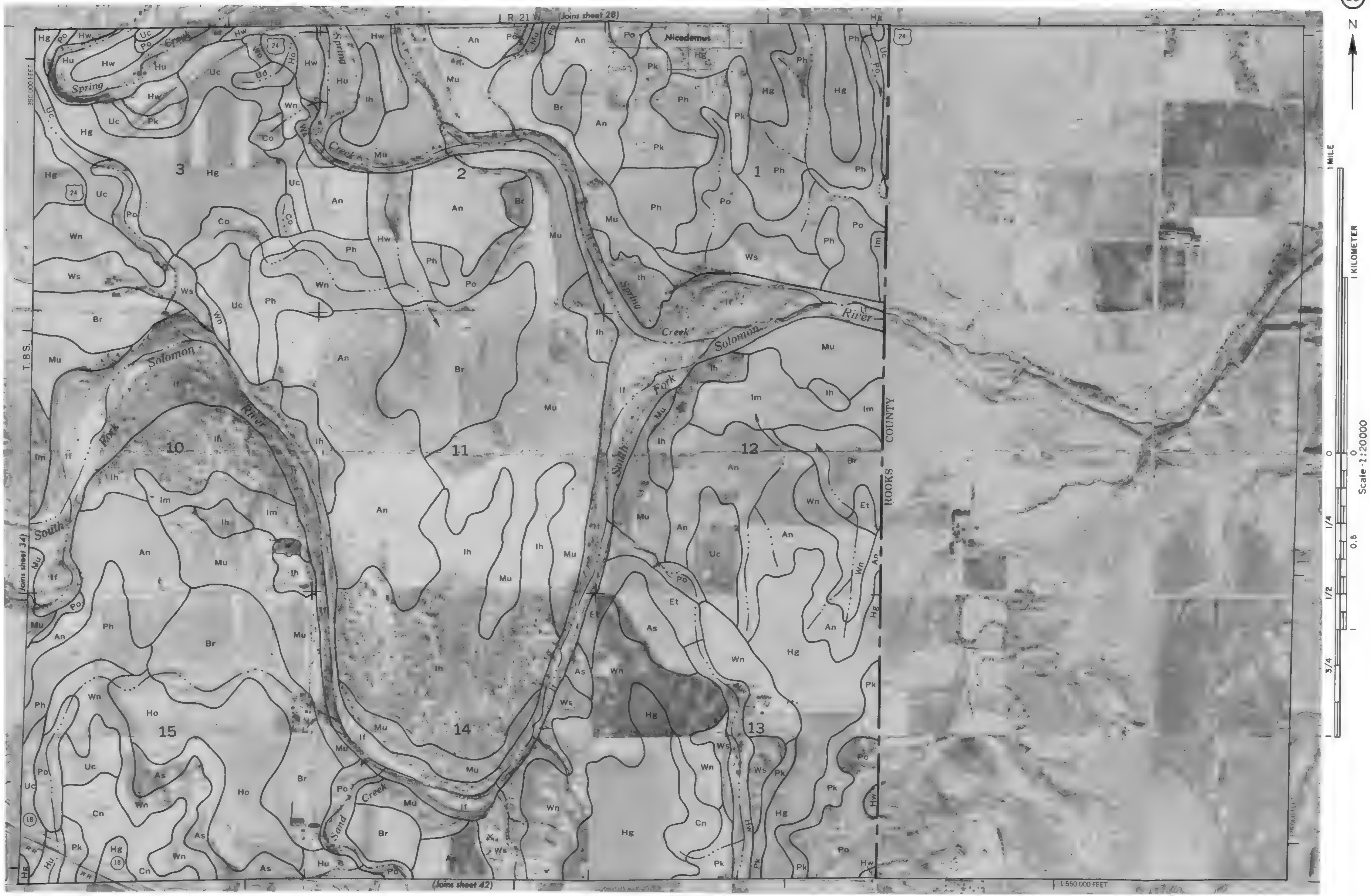
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 34

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

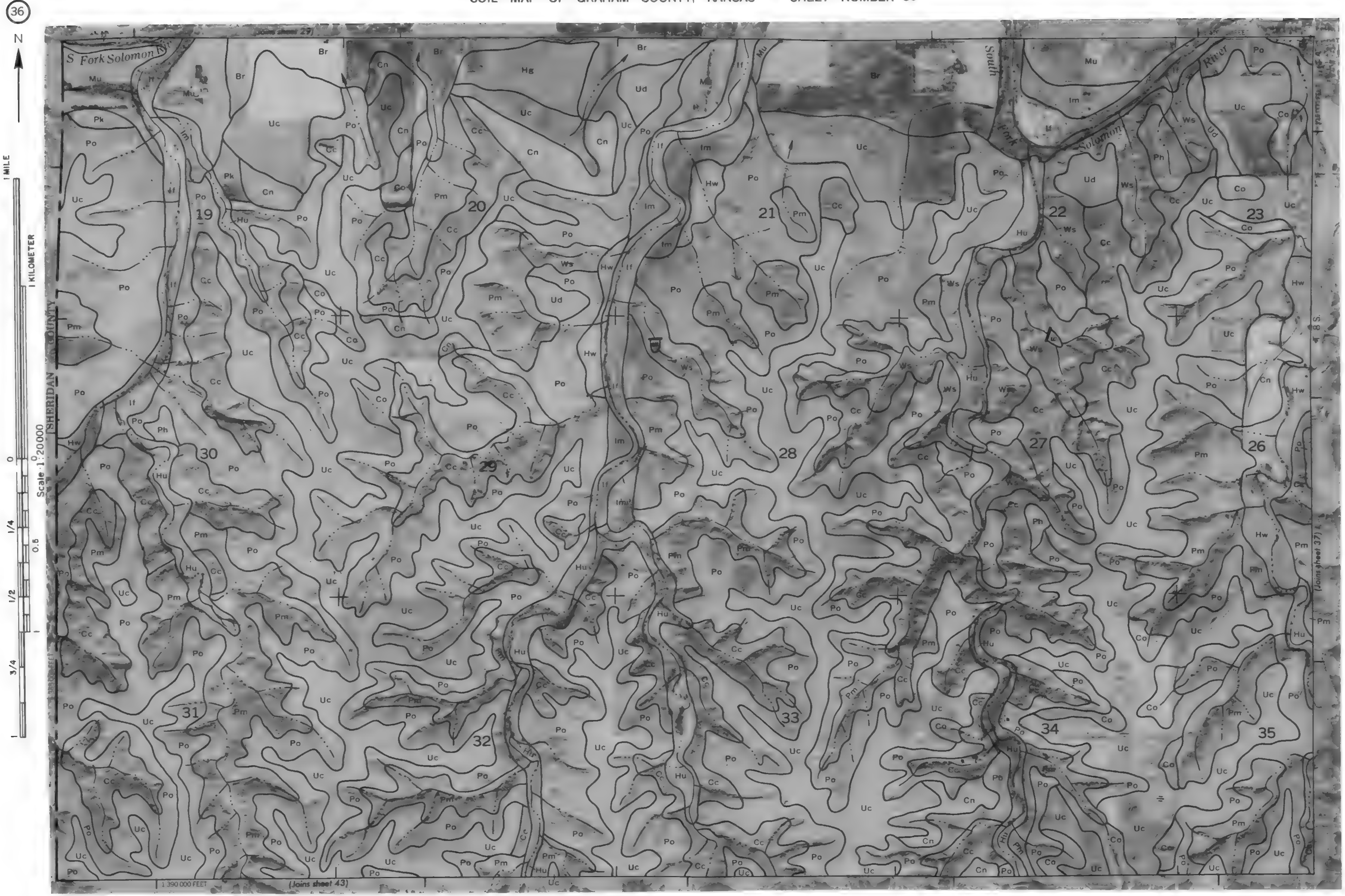
GRAHAM COUNTY, KANSAS NO. 34

GRAHAM COUNTY, KANSAS NO. 35

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 36



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 36

GRAHAM COUNTY, KANSAS NO. 37

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 38

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 38

GRAHAM COUNTY, KANSAS NO. 39

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners if shown are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 40

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

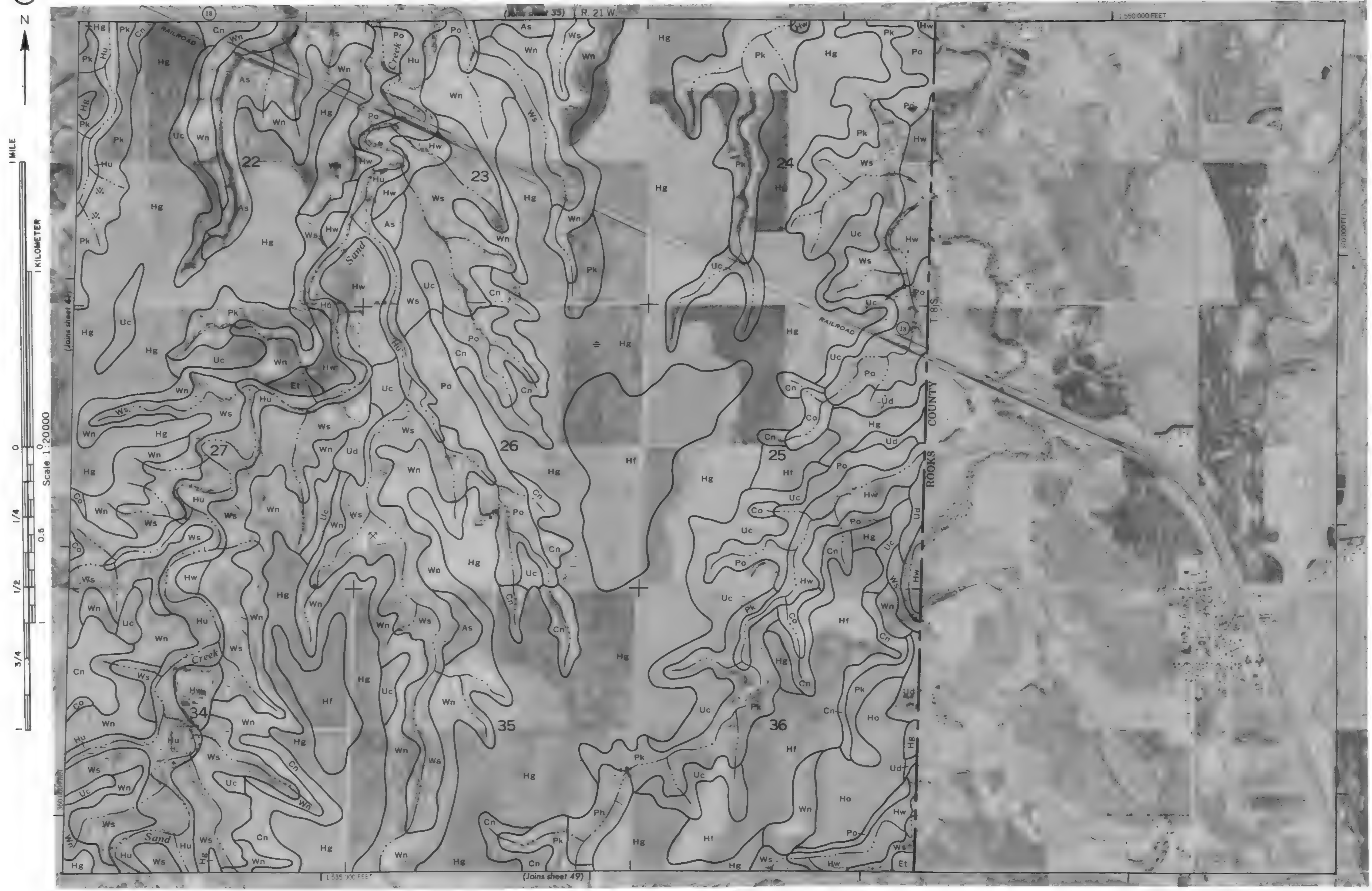
GRAHAM COUNTY, KANSAS NO. 40

GRAHAM COUNTY, KANSAS NO. 41

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

42

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 42



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 42

43

N

1 MILE

1 KILOMETER

Scale 1:20000

GRAHAM COUNTY, KANSAS NO. 43

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 44

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

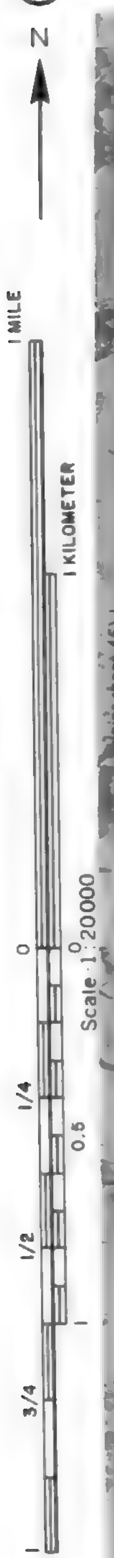
GRAHAM COUNTY, KANSAS NO. 44

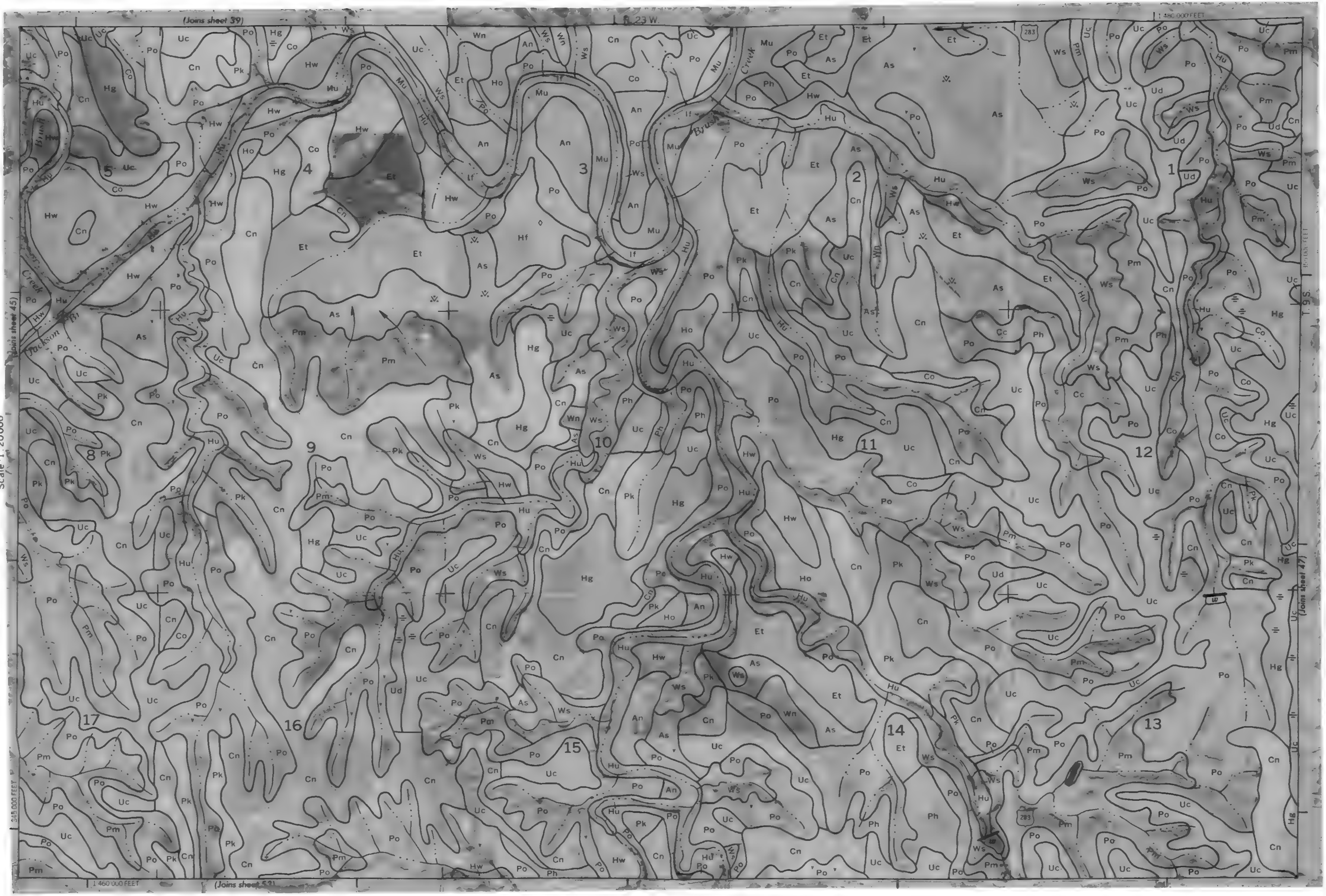
45

GRAHAM COUNTY, KANSAS NO. 45

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 46



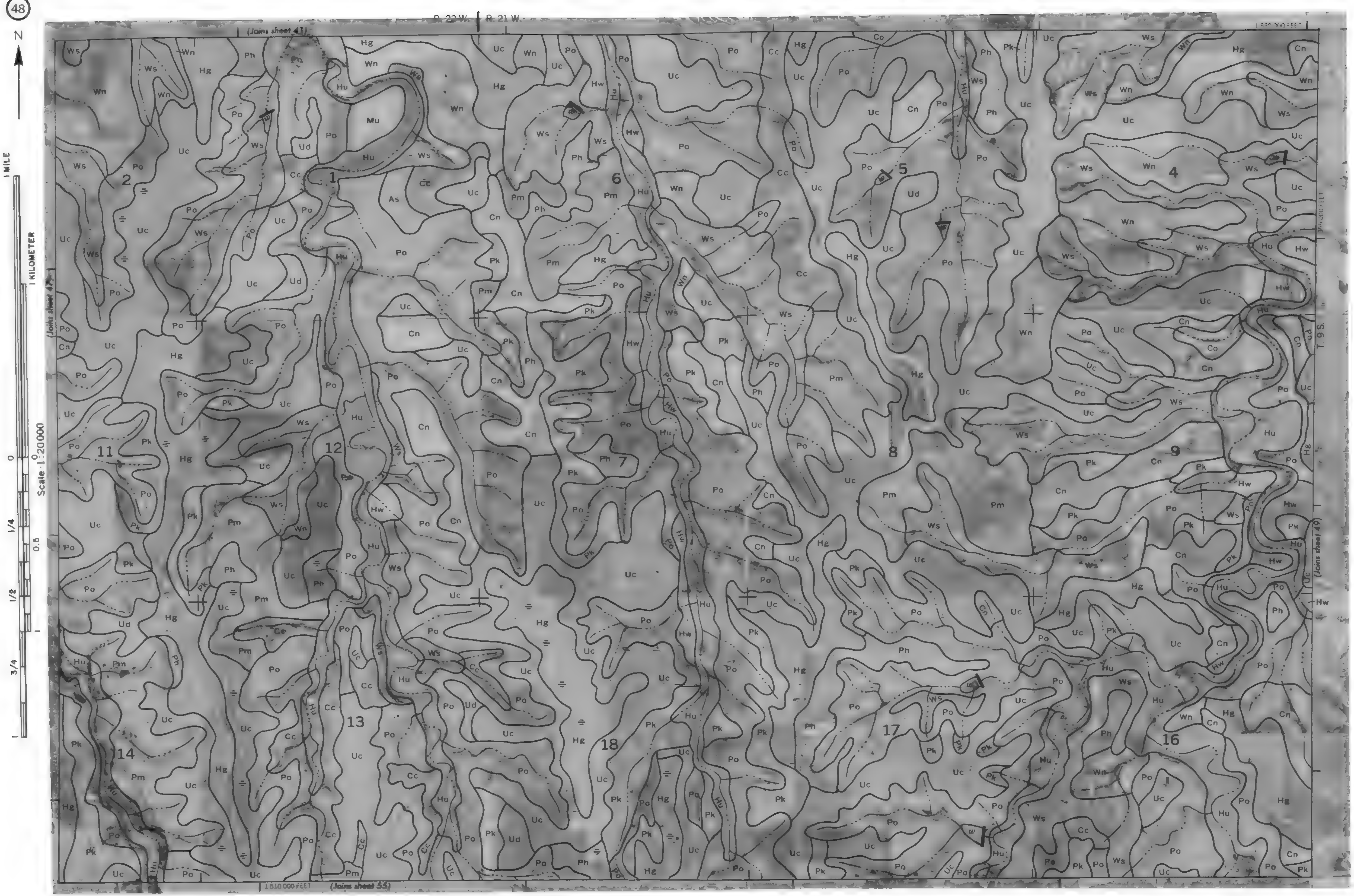


This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 46

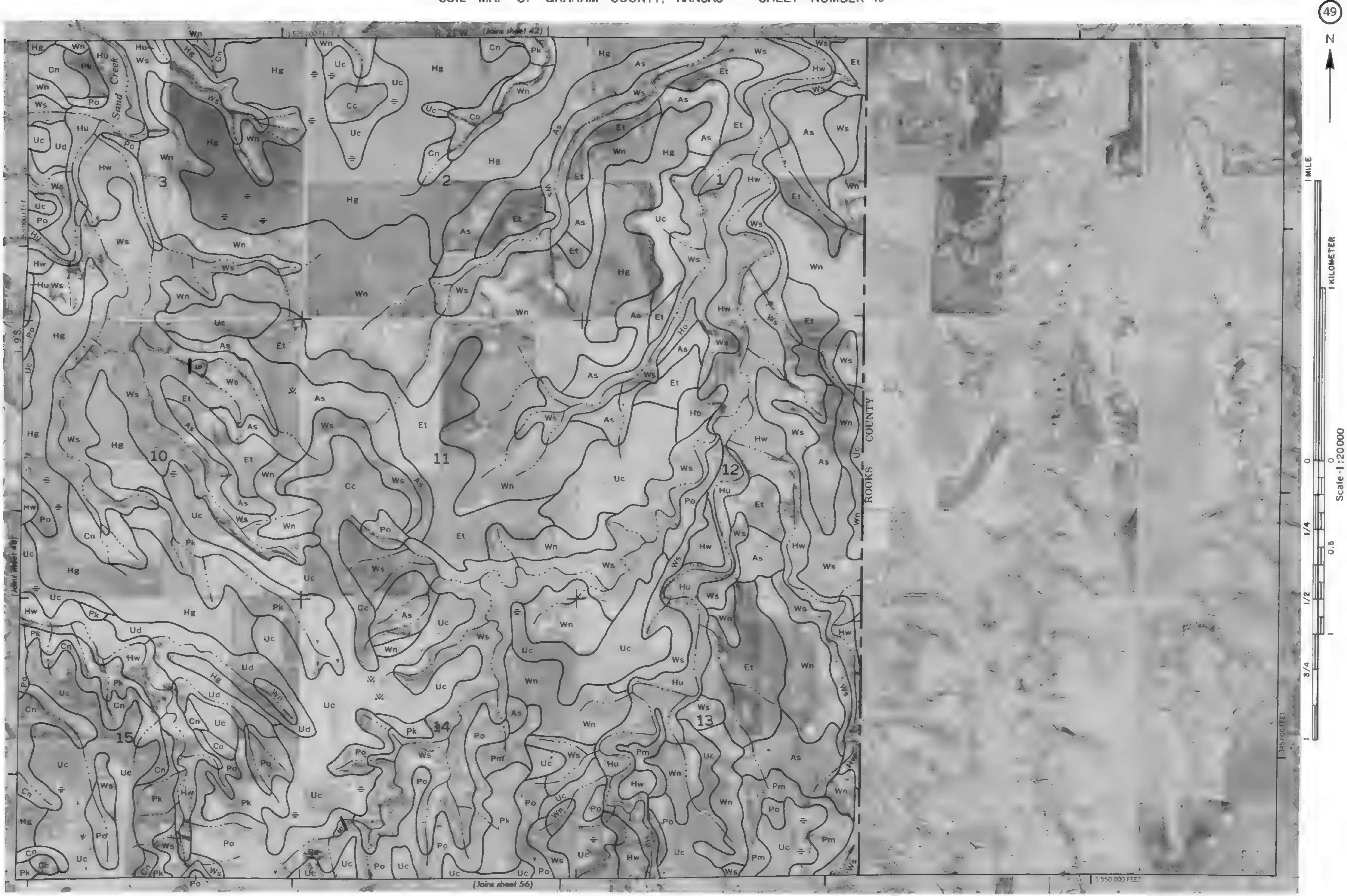
GRAHAM COUNTY, KANSAS NO. 47

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

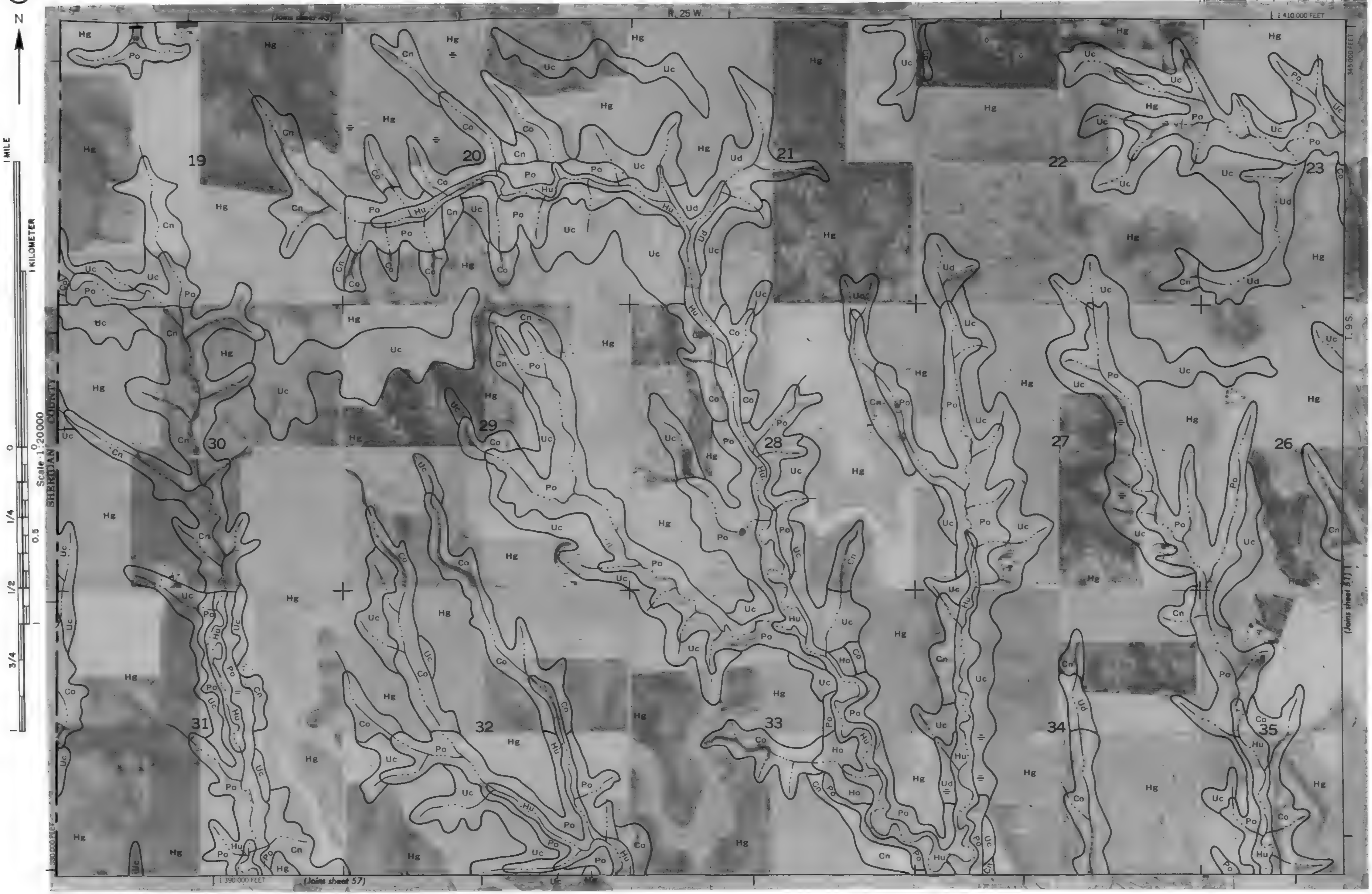
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 49



GRAHAM COUNTY, KANSAS NO. 49

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 50



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

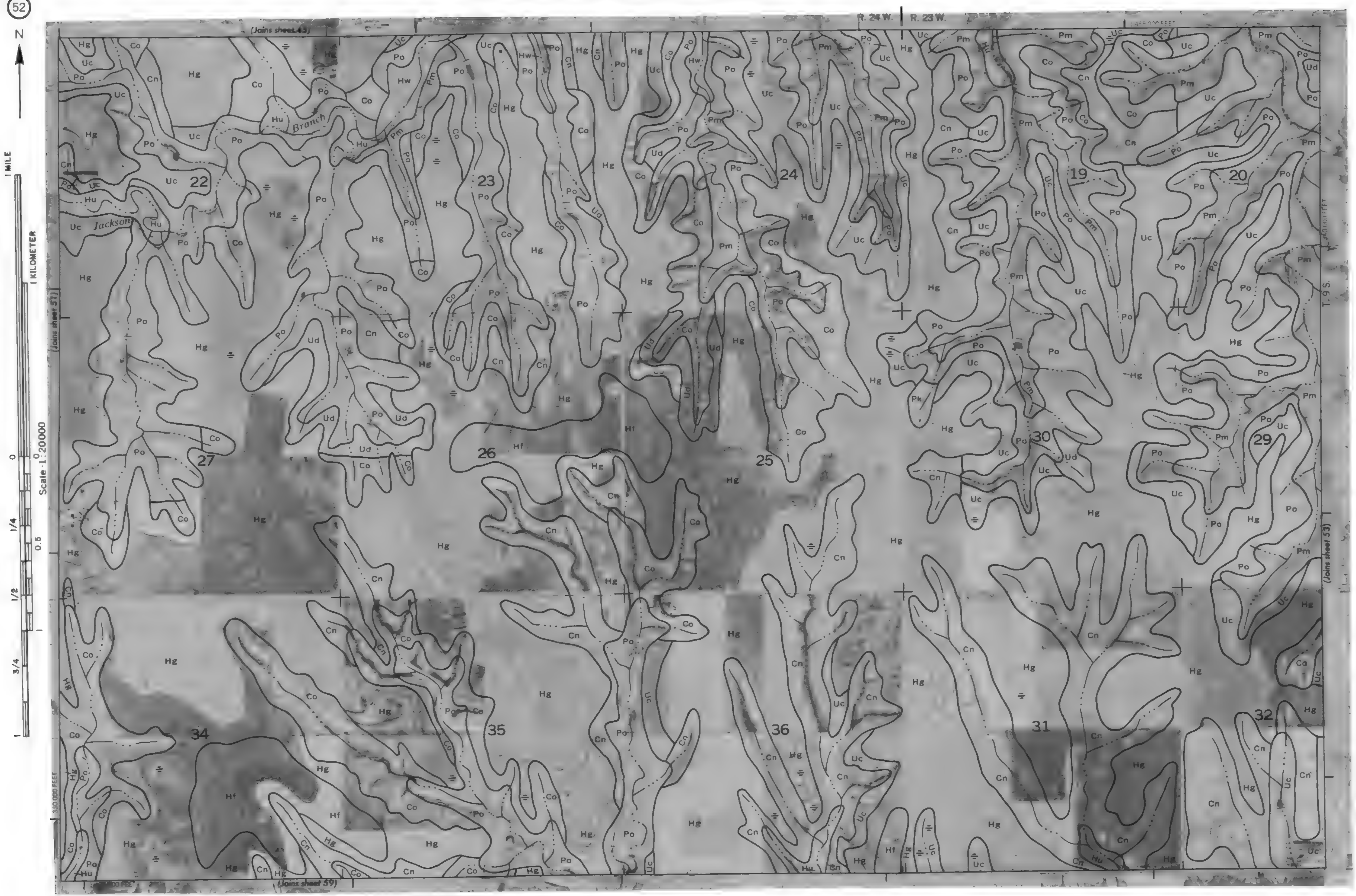
GRAHAM COUNTY, KANSAS NO. 50

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 51

GRAHAM COUNTY, KANSAS NO. 51

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 52



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 52

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 53

GRAHAM COUNTY, KANSAS NO. 53

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 54

54

N

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 54

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 55

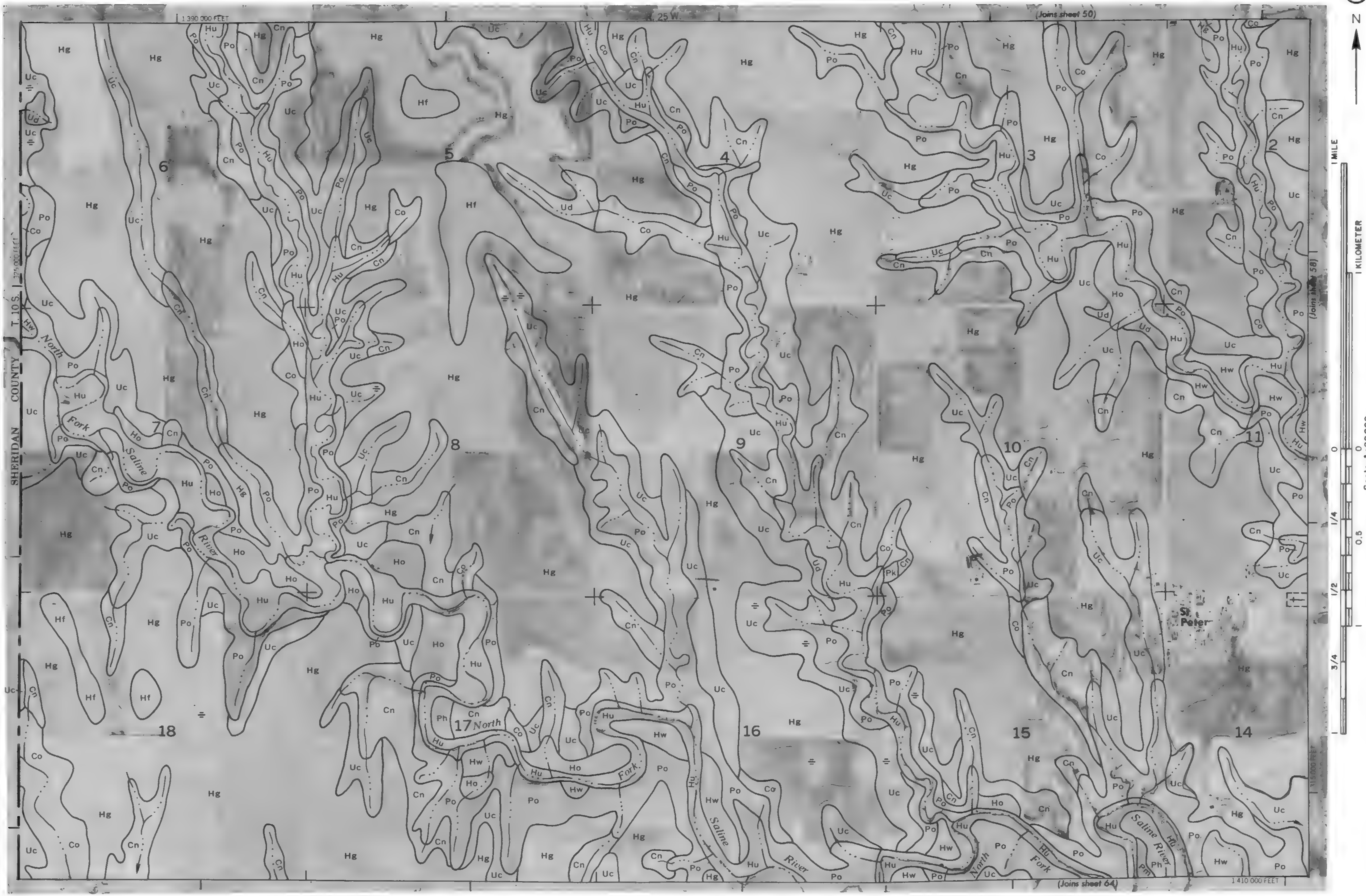
GRAHAM COUNTY, KANSAS NO. 55

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 56

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 57



GRAHAM COUNTY, KANSAS NO. 57

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

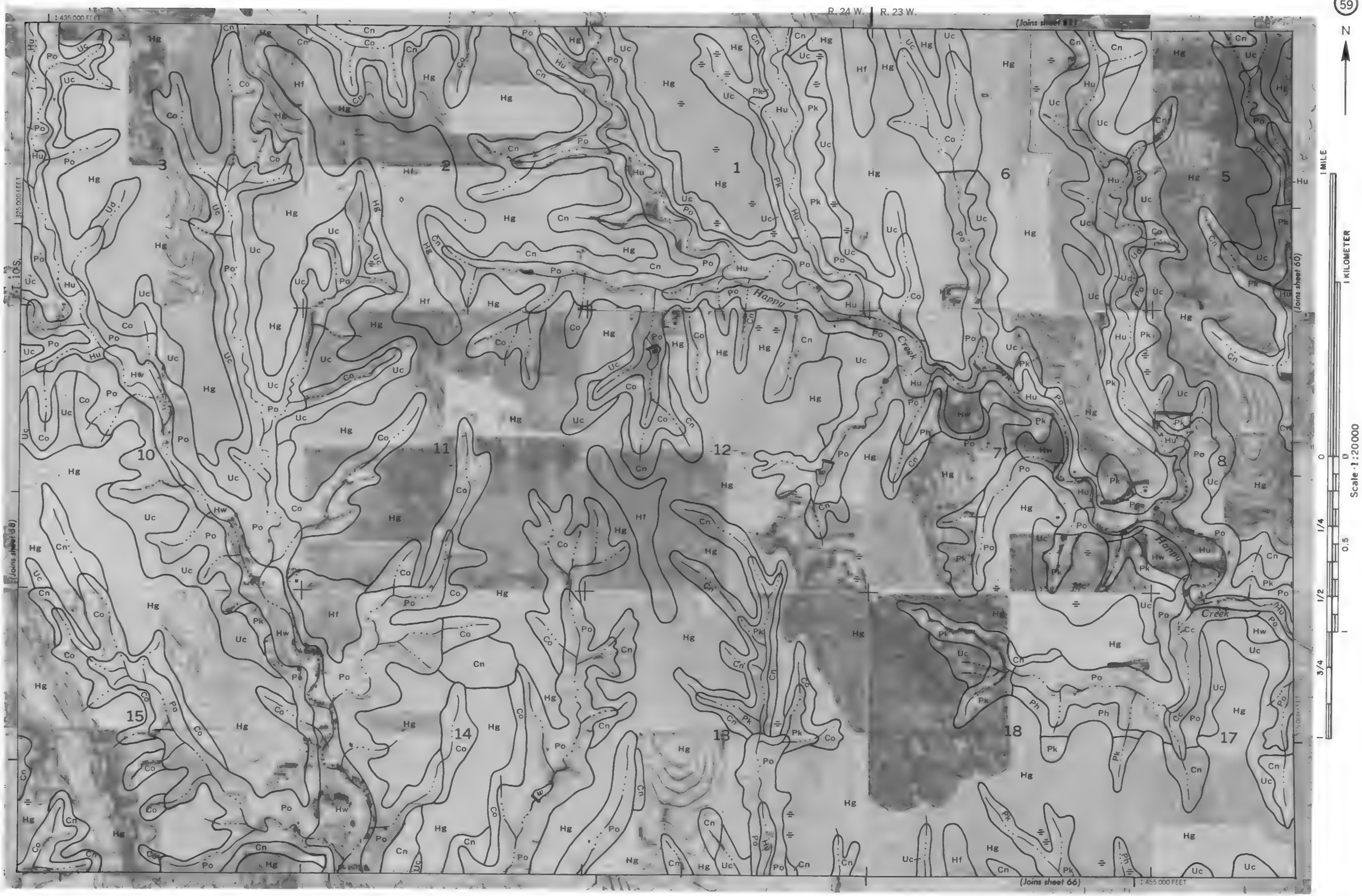
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 58

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 58

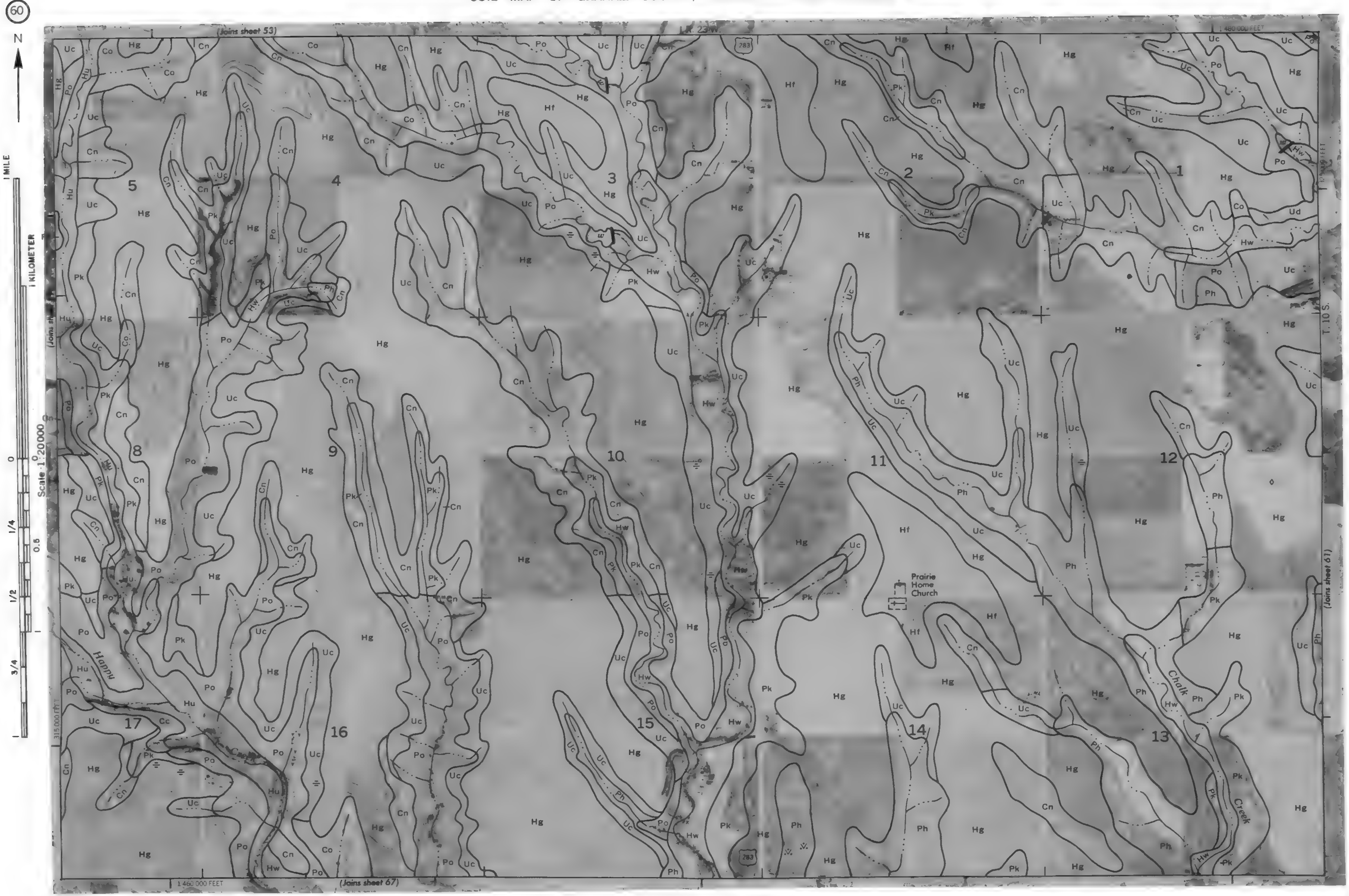
SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 59

59



GRAHAM COUNTY, KANSAS NO. 59

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners if shown are approximately positioned.



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 60

61

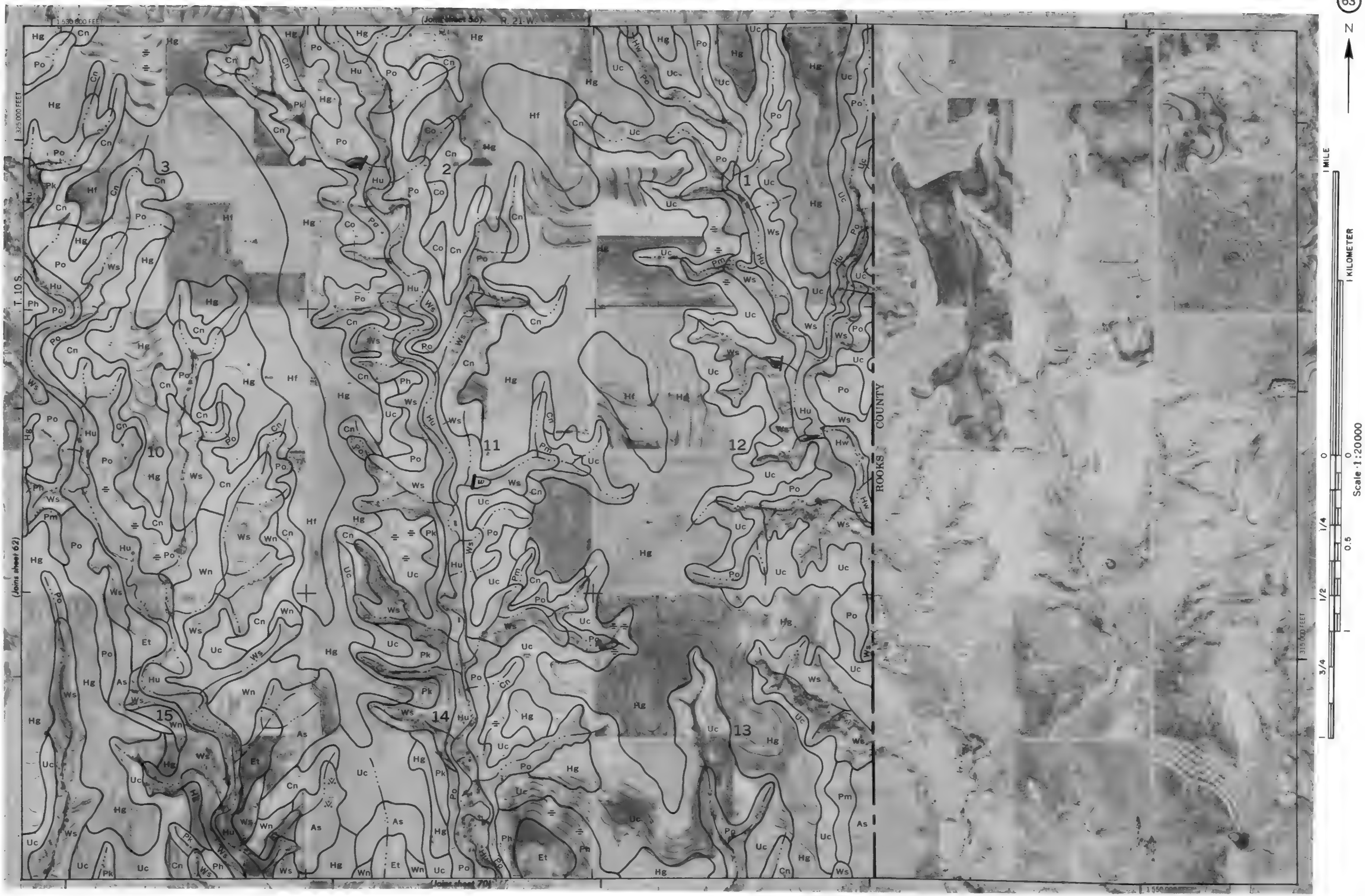
GRAHAM COUNTY, KANSAS NO. 61

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 62

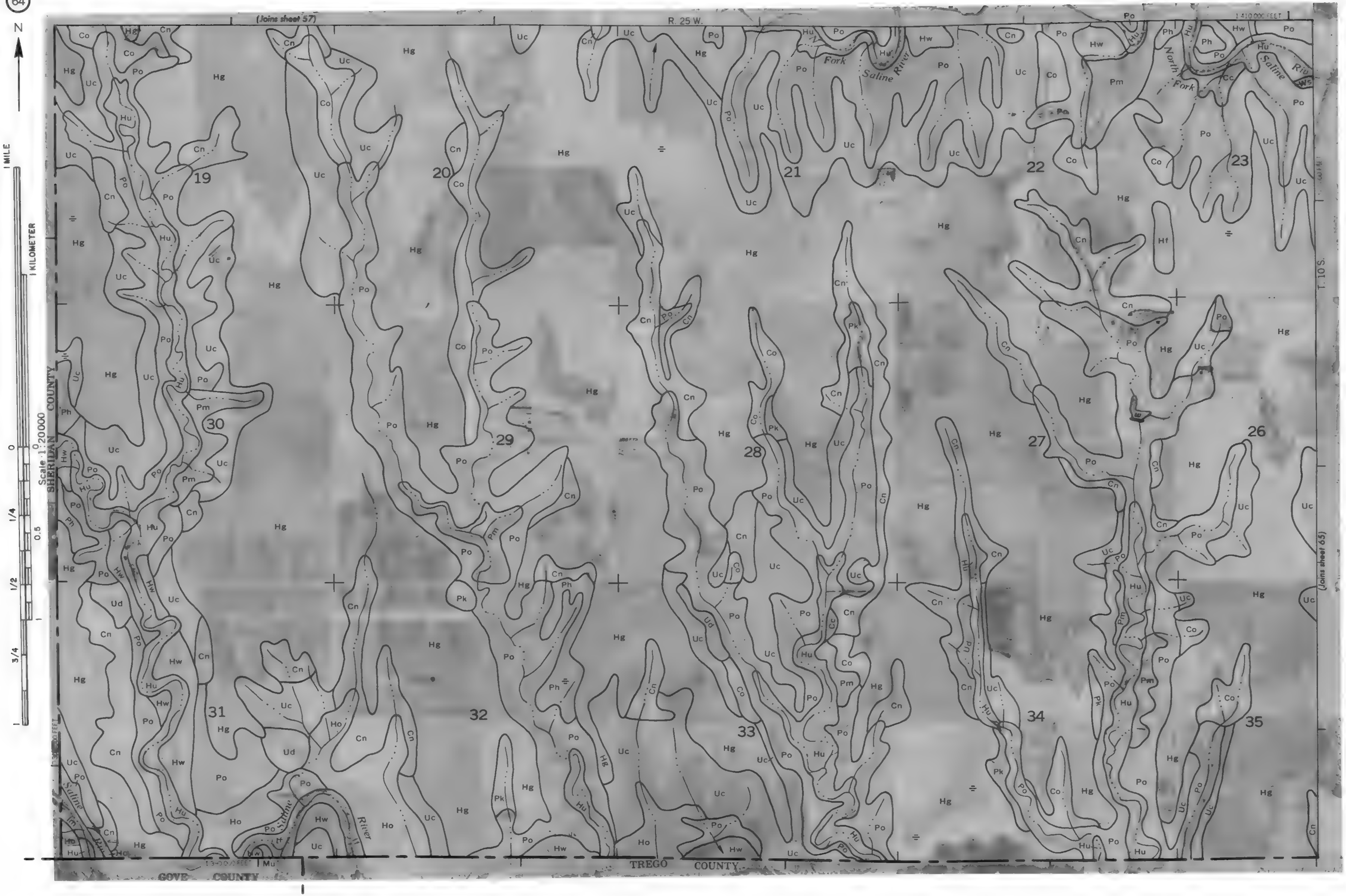
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 62

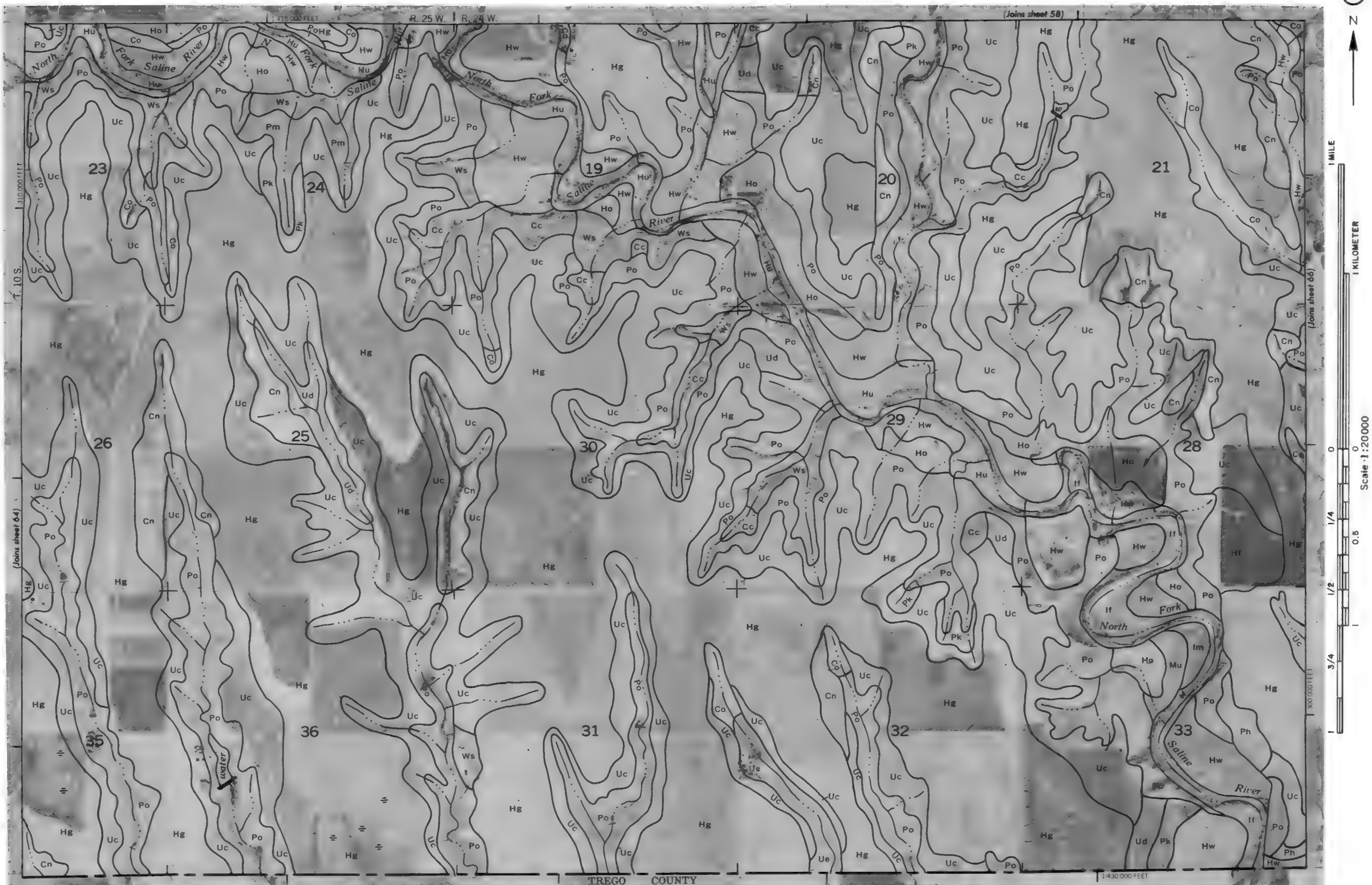


GRAHAM COUNTY, KANSAS NO. 63

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned



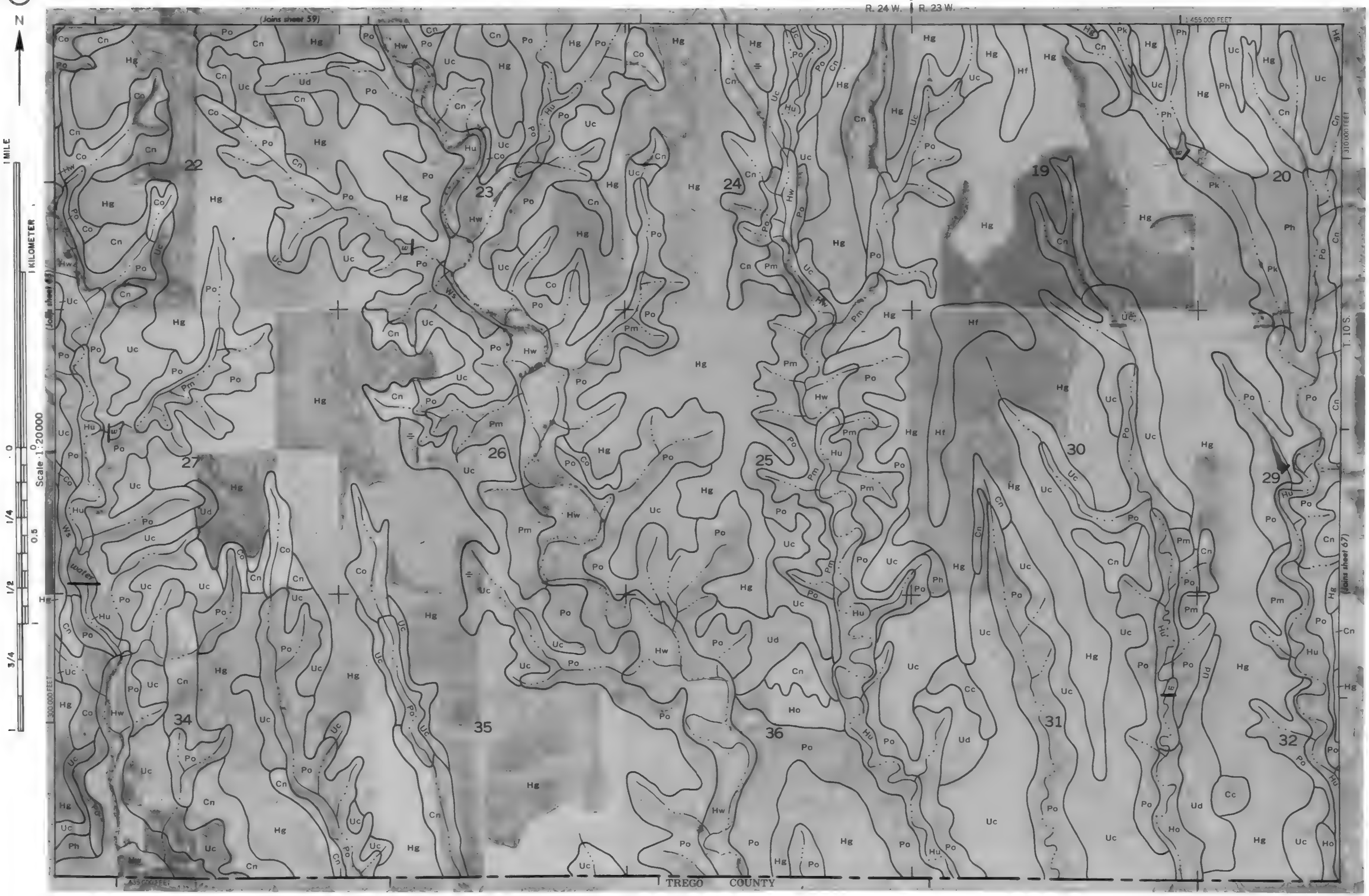
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



GRAHAM COUNTY, KANSAS NO. 65

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 66



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 66

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 67

GRAHAM COUNTY, KANSAS NO. 67

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 68

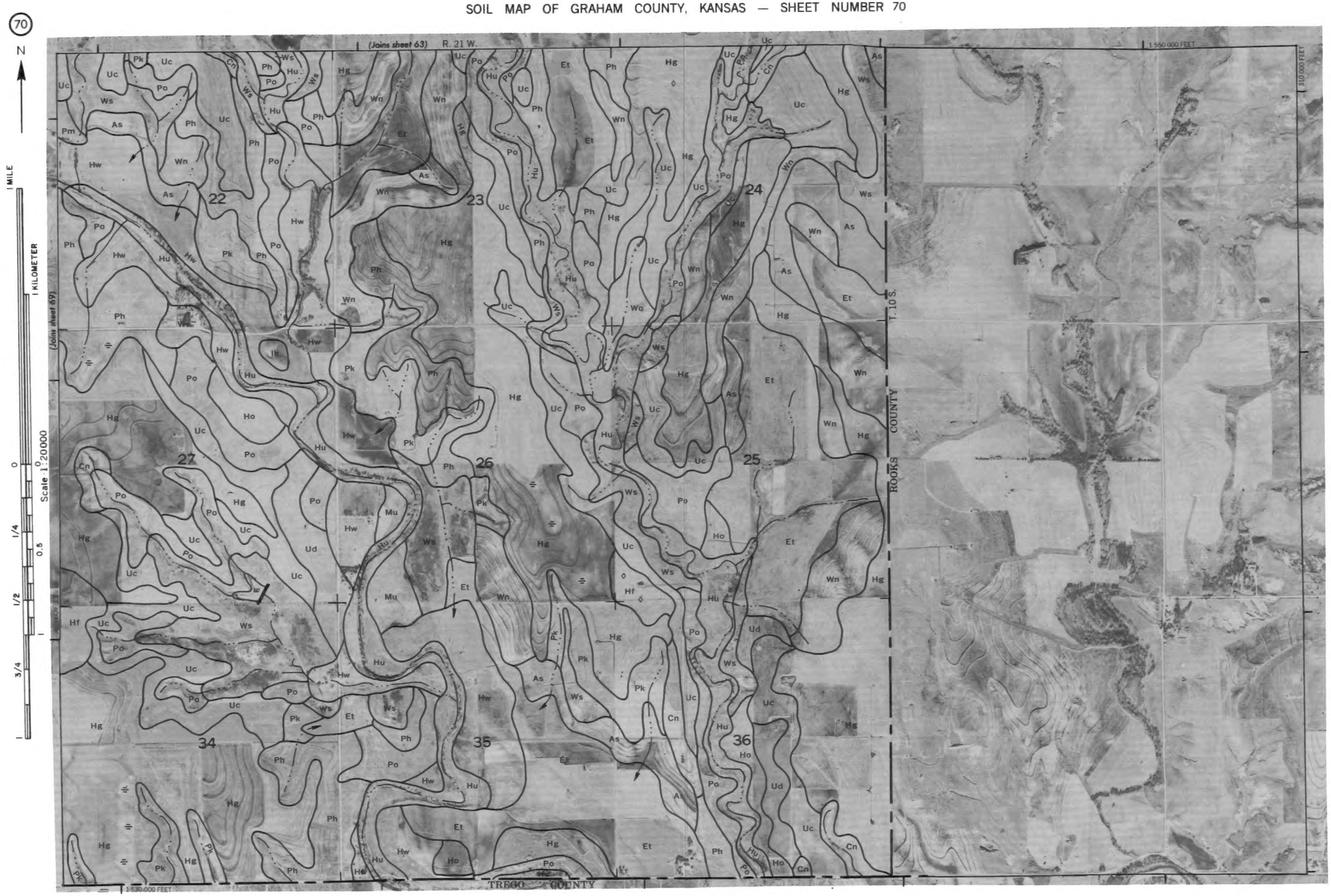
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

GRAHAM COUNTY, KANSAS NO. 68

GRAHAM COUNTY, KANSAS NO. 69

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF GRAHAM COUNTY, KANSAS — SHEET NUMBER 70



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies
Coordinate grid ticks and land division corners, if shown, are approximately positioned

GRAHAM COUNTY, KANSAS NO. 70